



MAUL
FOSTER
ALONGI

PORTLAND HARBOR PROPOSAL PLAN COMMENTS

SILTRONIC CORPORATION

PREPARED FOR
SILTRONIC CORPORATION
SEPTEMBER 6, 2016
PROJECT NO. 8128.02.03

PIONEERING CHANGE WITH INNOVATIVE SOLUTIONS

RECEIVED
OREGON OPERATIONS OFFICE

SEP 06 2016

EPA-REGION 10

PORTLAND HARBOR PROPOSED PLAN COMMENTS

SILTRONIC CORPORATION



Prepared for
SILTRONIC CORPORATION

September 6, 2016
Project No. 8128.02.03

Prepared by
Maul Foster & Alongi, Inc.
2001 NW 19th Avenue, Suite 200, Portland OR 97209

PORTLAND HARBOR PROPOSED PLAN COMMENTS

SILTRONIC CORPORATION

*The material and data in this report were prepared
under the supervision and direction of the undersigned.*

MAUL FOSTER & ALONGI, INC.

*Phil Wiescher, PhD
Environmental Scientist*

*Madi Novak
Principal Scientist*



EXPIRES: 12/31/2016

This digital seal certifies the signatory
and document content.

*Erik Bakkom, PE
Environmental Engineer*



EXPIRES: 5/31/2017

This digital seal certifies the signatory
and document content.

*James Peale, RG
Principal Hydrogeologist*

OVERVIEW

On behalf of Siltronic Corporation (Siltronic), this document has been prepared to provide comments on the U.S. Environmental Protection Agency (EPA) Portland Harbor Superfund Site (Site) Proposed Plan (PP) dated June 8, 2016. In some cases, the comments refer to the EPA Site Feasibility Study (FS), dated June 2016, and the EPA-approved Site Remedial Investigation (RI), dated February 2016, which provide the basis for the PP.

Siltronic appreciates the significant efforts by EPA and partner agencies to move toward a final cleanup plan for the Site. Siltronic has worked cooperatively with EPA and partner agencies for 15 years to protect human health and the environment.

Siltronic is in a unique position in that, when Siltronic purchased the property from the City of Portland in 1978, portions had been used primarily as a waste discharge and impoundment area by Portland Gas & Coke (PG&C), now known as NW Natural (NWN), from the 1940s through the early 1960s. Tugboat refueling, oil off-loading, and log storage also were conducted along the riverbank. Subsequent property owners began filling the property with up to 30 feet of additional material, including dredge spoils. The environmental legacy of the property was not evident when Siltronic purchased the property in 1978.

Siltronic is situated adjacent to two sediment decision units (SDUs)—SDU6W and SDU7W, also described by EPA as the Gasco and Arkema SDUs, respectively—for which the focus contaminants of concern (COCs) are unrelated to Siltronic operations, and for which differing remedial action levels (RALs) are identified in the EPA's preferred Alternative I. Actions implemented in these two SDUs have significant implications for Siltronic operations. Siltronic requests that EPA consider this context when reviewing the following comments.

Siltronic is pleased to have this opportunity to provide comments on the PP, and appreciates EPA's review of the comments. The primary issues identified below represent the most important concerns. Detailed comments and recommendations for addressing each issue are provided in the sections that follow.

- **“Known Contaminated” Riverbank Designation.** The entire Siltronic riverbank is not known to be contaminated and the riverbank erosion pathway is incomplete; the “known contaminated” designation should be removed;
- **Riverbank Remedy Assessment.** If remedial action objective 9 (RAO 9) is included in the record of decision (ROD), EPA should provide a basic framework that includes assessment to determine the need for remedy and allows for a remedy alternatives evaluation. In this way an appropriate remedy that acknowledges site-specific constraints can be identified. The ROD should clearly define performance criteria (such as erosion prevention and seismic stability) to ensure that EPA's PP does not threaten Siltronic manufacturing buildings that are located close to the riverbank;
- **Basis for Sediment Management Area (SMA) Extent in SDU7W.** There is an unwarranted increase of the sediment remedy area off-shore of Siltronic, driven by non-focus COCs. This

area can be minimized while achieving the intended risk reduction by implementing RALs that are more appropriate for non-focus COCs in SDU7W, or by extending SDU6W to include the entire Siltronic shoreline;

- **Gasco-Related Sediment Recontamination Potential.** PG&C nonaqueous-phase liquid (NAPL) is present in the subsurface at the Gasco site. EPA should integrate upland source control with in-water remedy to avoid sediment recontamination;
- **Waste Determination.** Misclassification of creosote production, refinery operations, and chemical manufacturing waste from the former PG&C facility as purely “manufactured gas plant waste” may result in improper classification and handling of sediment. EPA should require proper waste disposal sampling and characterization; and,
- **Design and Implementation Flexibility.** The remedial technology selection approach for sediment cleanup appears to be overly prescriptive. Remedial means and methods should not be prescribed, because additional predesign information is necessary to develop a design with the right balance of implementability, efficiency, effectiveness, and environmental protection.

PRIMARY ISSUE 1—“KNOWN CONTAMINATED” RIVERBANK DESIGNATION

Issue Description

The riverbank region for the Site is described as 30,048 lineal feet of “area along the shoreline next to contaminated shallow areas that is also contaminated” (see PP page 12). In subsequent text and figures, this area is referred to as the “known contaminated” riverbank (see PP Figure 6). Under the preferred Alternative I, excavation and capping are proposed for 19,472 lineal feet of riverbank (see PP Table 5), including the Siltronic shoreline. While the FS acknowledges that “data density is insufficient” to delineate areas for the remedy (see FS page 3-12), it is nevertheless assumed that in-water SMAs extend to riverbanks designated as “known contaminated.” Since active remediation is proposed for most of the in-water area adjacent to Siltronic¹ (see PP Figure 19d), it appears that EPA is proposing a remedy for most of the riverbank as well.²

As further described in the comments below, data have not been collected along much of the Siltronic riverbank, and based on the conceptual site model for this site, the riverbank may not be contaminated. In addition, the Oregon Department of Environmental Quality (DEQ) has designated this riverbank as low priority for source control. Since the entire Siltronic riverbank is not known to be contaminated and the riverbank erosion pathway is incomplete, the “known contaminated” designation for the Siltronic riverbank is unsupported and unwarranted.

¹ Note that subsequent comments discuss the designation of the SMA in SDU7W.

² The PP and FS do not provide figures or sufficient text describing how the riverbank region or the proposed riverbank remedy areas are spatially defined.

Because no upland media were evaluated as part of the EPA-approved RI conducted to inform the FS, EPA should remove RAO 9 and continue to coordinate with DEQ as the latter addresses upland source control as it is required to do under the 2001 Memorandum of Understanding. Alternatively, Siltronic requests that EPA clarify in the FS and the ROD that any action regarding riverbank remedy is subject to additional assessment.

Comments

The Siltronic riverbank is not known to be contaminated. Riverbank areas presumed by EPA to be contaminated should be defined in the ROD as “potentially” contaminated and should be subject to further assessment if RAO 9 is included in the ROD.

The PP and FS do not provide the basis for the “known contaminated” designation. In the PP, it is indicated that “more information” is included in the FS Appendix A riverbank database³ (see PP page 13). The database includes a disclaimer indicating that “these data have not been checked for accuracy, or usability and are presented as is with no warranty expressed or implied regarding utility of the data...this data compilation is not designed for use as a primary regulatory tool in permitting or citing decisions.” It is unclear how a database that has not been evaluated for accuracy or usability can be relied on to designate the entire Siltronic riverbank, let alone over 30,000 lineal feet at the Site, as contaminated. The database is also missing critical information, such as location coordinates, and includes various data unrelated to riverbank soils (e.g., tissue and water samples). It appears that data from the vicinity of the northern Siltronic shoreline (i.e., near the Gasco area) were included in the database. These data were not collected from the riverbank (see below), nor were they collected for the purpose of developing or evaluating remedial alternatives. No data for the middle and southern shoreline portions were included.⁴ EPA does not indicate how or if the available data were screened to determine presence of contamination.⁵

The FS text also provides little information for the basis of the designation, stating that: “contamination associated with historical MGP waste is known to be present in the northern portion of the Siltronic river bank...river bank contaminants include PAHs, gasoline-range hydrocarbons, diesel-range hydrocarbons, residual-range hydrocarbon, cyanide, and metals (zinc)” (FS page 1-18). The text indicates that “information on these river banks is available in DEQ’s ECSI database” but does not indicate what this information is (e.g., is it data, and if so, were the data screened to conclude that the riverbank was contaminated?). Again, it is unclear how an unsupported statement about the northern portion of the riverbank provides justification for designating the entire riverbank as contaminated.

Furthermore, there is a discrepancy between comments from EPA and comments from DEQ as to how the “known contaminated” riverbank reaches were determined. On July 10, 2016, the Lower Willamette Group prepared a list of questions on the PP, including “how were the properties with

³ Note that the FS submittal did not include Appendix A, which was subsequently obtained via request to EPA.

⁴ Note that two sample locations near the Siltronic southern shoreline are included in the riverbank database: R2-RP-02-TR and LWG0106R004CR20. The data collected at these locations are transition zone water (TZW) and tissue samples, respectively, and are not applicable for determining riverbank soil conditions.

⁵ Note that RAO 9 riverbank “soil/sediment” preliminary remediation goals (see PP Table 9) are values derived for sediment and should not be applied to riverbank soils; for example, the arsenic value (3 milligrams per kilogram [mg/kg]) is well below the DEQ defined background for upland soils in the Portland Basin (8.8 mg/kg).

known contaminated riverbanks identified in Figure 6 of the Proposed Plan determined...?” In an e-mail dated July 20, 2016, EPA indicated that contaminated riverbanks had been identified by DEQ; this is inconsistent with the discussion provided in the PP and FS (see above). In addition, DEQ has reiterated in meetings with Siltronic that they do not consider the southern three-quarters of the riverbank (i.e., Segment 3 area; see Figure 1) as a high priority because: (1) the bank is heavily armored; and (2) it is unlikely that there is significant contamination that would require removal.

As DEQ indicates, the Siltronic riverbank is heavily armored with riprap that extends from an elevation of approximately 10 to 12 feet North American Vertical Datum of 1988 (NAVD88) from the toe of the slope to approximately 30 to 36 feet NAVD88 at the top of the slope, where the generally level portions of the upland property begin.⁶ As the riverbank contains no sampling locations (see Figure 1), it cannot be known to be contaminated. In addition, the riverbank substrate and structure are entirely different than adjacent sediment and top-of-the-bank soils. Therefore, such associated data are not applicable for making determinations regarding the riverbank at Siltronic.

In summary, available data are insufficient for determining the nature and extent of contamination at the Siltronic riverbank, and further evaluation would be needed to inform whether contamination is actually present. No upland media were evaluated as part of the EPA-approved RI conducted to inform the FS. Therefore, EPA should remove RAO 9. If RAO 9 is carried forward into the ROD, Siltronic requests that EPA clarify in the ROD that any action regarding riverbank remedy is subject to additional assessment, as further described below and in Primary Issue 2.

The Siltronic riverbank erosion pathway is incomplete. EPA should acknowledge that remedy may not be required in such cases.

The Siltronic riverbank is heavily armored with riprap. As stated by DEQ in the 2016 Portland Harbor Source Control Summary Report, because the riverbank is heavily armored with basalt, “the potential for contaminated bank material to enter the river is low...and sediment recontamination potential pending an integrated sediment remedy is also low.”⁷ In Figure 4.6.6 of the same report, the entire southern three-quarters of the Siltronic riverbank (i.e., Segment 3; see Figure 1) was not highlighted, indicating that there are no current or expected future DEQ bank actions along that reach. In addition, site stormwater either infiltrates or is managed under a stormwater system that discharges to the river under a National Pollutant Discharge Elimination System 1200Z industrial stormwater general permit. Under this permit, Siltronic has been granted waivers for 15 of the 18 required parameters because of the effectiveness of Siltronic’s stormwater management practices. Therefore, the potential for overland flow carrying eroded soil to the riverbank and the river is very low.

To further evaluate the riverbank erosion pathway, the DEQ-recommended bank stability scoring matrix (Bank Assessment for Non-point Source Consequences of Sediment, developed by the U.S. Fish and Wildlife Service) was applied to the Siltronic riverbank. Maul Foster & Alongi, Inc., completed this assessment, which includes photographs and scoring matrices, in May 2016 (see the attachment). Multiple riverbank transects were evaluated, and all transects scored “very low” to “low”

⁶ Note that the PP and FS do not define the spatial extents of the riverbank region in text and that the figures show a line rather than areas.

⁷ DEQ, Portland Harbor upland source control summary report. Oregon Department of Environmental Quality, March 25, 2016.

risk for streambank erodibility. Since soil transport potential to the river is low, remedy should not be required.

PRIMARY ISSUE 2—RIVERBANK REMEDY ASSESSMENT

Issue Description

In the FS and the PP, EPA has identified riverbanks that are known to be contaminated and that require remediation. As described above, EPA has not provided the basis for designating the Siltronic riverbank as contaminated or for verifying the nature and extent of contamination and river recontamination potential. If RAO 9 is included in the ROD, we ask EPA to provide a basic riverbank remedy framework in the ROD that provides for contaminant and transport assessment to determine if a remedy is warranted and, if it is, provides for a remedy alternatives evaluation that considers standard FS criteria. Without a basic framework, Siltronic cannot develop an evaluation of the riverbank conditions to determine the need for a remedy, or select an appropriate remedy if warranted.

Siltronic is located along a very steep, heavily armored riverbank (see Figure 2), which would make for a very challenging investigation, assessment, and design process, should one be necessary. If contamination requiring remediation were to be identified, even limited removals in very small areas at the base of the Siltronic riverbank likely would pose significant geotechnical challenges and costs because of the steepness of the underlying riverbed and revetted bank, in addition to significant concerns regarding the foundations of structures and other infrastructure. EPA should therefore clearly account for site-specific riverbank remedy constraints in the ROD.

Comments

EPA has not provided an adequate riverbank remedy framework. If implementing RAO 9, EPA should provide a basic framework that includes (1) assessment of the presence and stability of contamination in the riverbank zone, and (2) development of a remedy alternatives evaluation that acknowledges site-specific constraints.

Remedy of riverbank soils, particularly if integrated with an adjacent sediment remedy, is a complex process that EPA has addressed in the PP with broad assumptions and unclear criteria. EPA should provide a remedy framework that focuses on: (1) the presence and stability of contamination that may be subject to release to surface water/sediments as a result of chemical fate and transport mechanisms, NAPL migration, surface erosion, and geotechnical slope failure (under static and seismic conditions); and (2) development of a riverbank evaluation process to address any identified unacceptable condition or pathway for the release of contamination from the riverbank (i.e., removal of near-surface contaminated bank soils; containment of mobile contaminants; and provision of physical stability of riverbank for reasonably foreseeable conditions [surface water erosion, flood erosion, river traffic impacts, static and seismic stability, etc.]).

EPA has not provided a remedy evaluation process in the PP or FS (removal and capping is assumed for the entire Site). For sites where contamination and a transport pathway are identified, EPA should define a remedy evaluation process similar to a standard FS that can be informed by site-specific considerations, including geotechnical and hydrologic setting. Remedy alternatives could include

removal and containment, and the evaluation process should also allow for assessment of other alternatives.

The lack of a clear definition of the boundaries of the riverbank zone in the PP and the FS results in overlapping and potentially conflicting requirements for investigation and remediation. EPA should clearly define the transition from the shallow habitat zone to the riverbank zone (such as a change in the existing slope, a specific elevation, or other qualifying characteristic), as well as the upper boundary of the riverbank zone (such as the Mean Higher High Water Mark or observed top of bank). As an example, Siltronic's revetted waterfront rises steeply from the riverbed (elevation -37 feet) to the top of bank (elevation +30-36 feet) at slopes of 2H:1V (intermediate zone), 7H:1V (shallow water zone), and 1.7H:1V (riverbank) (see Figure 2). Siltronic is concerned that the current ambiguous definition of the riverbank zone would complicate the requirements for developing the baseline and supplemental design investigation for the sediment and riverbank areas, and would make the development of an integrated sediment and riverbank remedy significantly more complicated, should one be needed. Siltronic encourages EPA to define the riverbank zone boundaries clearly.

Between the FS and the PP, EPA has also introduced confusing design criteria for restored riverbank slopes, which will lead to significant misunderstanding by the public and the responsible parties during remedial design.

1. In describing the riverbank region in Section 3.4.5 of the FS, EPA defines the optimum slope for a riverbank as 5H:1V. In a footnote to that definition, National Oceanic and Atmospheric Administration (NOAA) Fisheries is referenced as having said that this was the "ideal slope for habitat considerations."
2. EPA goes on to state, in the FS text, that current industrial and commercial operations may have structures near the river that preclude obtaining this desired slope. The text descriptions of the alternatives presented in FS Section 3.8 state simply that a certain length of riverbank is "assumed" to be "laid back" and covered with a cap or vegetation.
3. Lastly, EPA's volume analysis in FS Appendix D for riverbank remediation appears to indicate that NOAA's recommended slope for habitat is not a requirement, since a 3H:1V slope is assumed.

Without further clarification, the public perception will be that EPA is accepting NOAA's recommended slope as a design criterion, even though EPA's own riverbank excavation volume estimates (and associated cost estimates) do not follow this guideline. The ROD should not specify design criteria, such as slopes, based solely on potential habitat improvement recommendations from NOAA.

Furthermore, EPA should state clearly in the ROD that site-specific factors such as infrastructure will be considered in determining appropriate slopes during riverbank remediation design. As an example, the excavation required to attain the "ideal habitat slope of 5H:1V" at the Siltronic property would result in undercutting and destabilization of several buildings and infrastructure integral to Siltronic's operations. This layback would also require the removal and reconstruction of the existing groundwater hydraulic control system that has been installed by NWN for source control. Finally, constructing the "ideal slope" would result in the removal of about 20 vertical feet of riverbank and

more than 55,000 cubic yards of soil that is already in a very stable and protective condition—only 2,000 cubic yards of this riverbank soil is below the ordinary high water line.

For these reasons, the ROD should clearly define a remedy development process and establish general performance criteria (e.g., slopes shall resist erosion of soils and be stable under static and seismic conditions) instead of prescribing specific slopes and erosion control techniques that may not be applicable to the location.

PRIMARY ISSUE 3—BASIS FOR SMA EXTENT IN SDU7W

Description

Under the preferred Alternative I, Alternative F RALs are applied in SDU7W to delineate the SMA for which active remedy is proposed (see PP Figure 9). SDU7W is described by EPA as the “Arkema” SDU (see FS Table 4.1-1) and it extends from approximately RM 6.6W, adjacent to Siltronic, to RM 7.8W near Arkema. The SDU is “focused COC-based”; the focus COCs are DDx (i.e., total sum of DDT, DDE, and DDD) and dioxins (PeCDF and TCDD) (see FS Table 4.2-1). The low Alternative F RALs apparently were therefore selected to achieve greater active remedy area coverage (i.e., a larger SMA) to reduce risks associated with DDx and dioxins, which are significantly elevated from approximately RM 6.8 to RM 7.5W near Arkema (see RI Maps 5.2-9 and 5.2-13).

Although SDU7W is focus-COC-based (as opposed to other SDUs that are “multiple COC-based”), Alternative F RALs are also applied for non-focus COCs. This has significant consequences that likely are unintended for the SDU7W portion offshore of Siltronic (RM 6.6 to 6.8), including an increase of the SMA that is unrelated to the focus COCs. Furthermore, this SMA increase does not provide warranted or equitable risk reduction in SDU7W, as further described below.

Note that Siltronic recognizes that sediment remedy delineation is subject to predesign sampling, and that SMAs shown in the PP are, to a certain extent, conceptual. However, regardless of preconstruction conditions, RALs that can result in SMA expansion unrelated to focus COCs and that are not applied in the vast majority of the Site, as is described in the PP, are inappropriate for determining the SDU7W SMA. As described below, this issue impacts the SMA offshore of Siltronic and the SMA upstream of Arkema; this is in part a consequence of the SDU boundaries that are not consistent with the focus COCs’ spatial distribution. Siltronic has not fully evaluated whether or to what extent this issue may affect other portions of the Site; however, similar issues may arise in other SDUs where SDU boundaries and focus COC distributions are not closely correlated.

Comments

Applying Alternative F RALs for non-focus COCs in SDU7W results in a significant increase of the SMA that is unrelated to the focus COCs. EPA should not apply Alternative F RALs for non-focus COCs.

Rather than targeting the focus COCs, EPA applied RALs for all of the COCs to delineate the SDU7W SMA (see FS Figures 3.4-7 through 3.4-12 and PP Figure 9). Siltronic used EPA methods to

recreate the Alternative F SMA footprint, as shown in Figure 3, for purposes of further evaluation.⁸ As shown in Figure 4, only 1 acre is identified as SMA in this area based on focus COC Alternative F RAL exceedances; applying F RALs for non-focus COCs results in 4.21 acres of additional remedy area. That is, the non-focus COCs account for approximately 80 percent (4.21 acres) of the total SMA footprint (5.21 acres) near Siltronic. Using all Alternative F RALs results in the unwarranted designation of additional SMA area near Siltronic (RM 6.6-6.8W) that is based exclusively on non-focus COCs (primarily total polychlorinated biphenyls [PCBs] and polycyclic aromatic hydrocarbons [PAHs]).

A significantly smaller active remedy area is identified in the RM 6.6-6.8W area if Alternative D or E RALs⁹ are applied for non-focus COCs while Alternative F RALs are retained for the focus COCs (see Figure 4). Application of Alternative E RALs would identify 1.8 acres, and 1.4 acres would be identified if applying D RALs and the “highly toxic” principal threat waste (PTW) level for PCBs (200 parts per billion [ppb]).¹⁰ In these cases, the focus COCs account for approximately 60 to 70 percent of the SMA, while RALs consistent with other areas of the Site are applied for non-focus COCs.

In contrast, use of Alternative D or E RALs for non-focus COCs minimally affects the SDU7W SMA portion offshore of Arkema (RM 6.9-7.5W) (see Figure 5). This is because elevated DDx and dioxins drive the SMA, as well as a small, substantially elevated PCB area that exceeds Alternative D, E, and F RALs. Upriver of RM 7.5W, DDx and dioxin concentrations significantly decrease and the approximately 4-acre SMA portion is mostly due to lower-level PCBs above the F RAL. Similar to the area offshore of Siltronic, this upriver area is relatively unaffected by the focus COCs, and just a 0.5-acre area would be identified as part of the SMA if more appropriate D or E RALs were applied for non-focus COCs (see Figure 5).

Applying Alternative F RALs for non-focus COCs in SDU7W arbitrarily assigns active remedy thresholds that result in estimated post-construction concentrations that are inconsistent with other areas of the Site. EPA should not apply Alternative F RALs for non-focus COCs in SDU7W.

When considering the SDU7W focus COCs (DDx, PeCDF, and TCDD), applying Alternative F RALs results in estimated post-construction concentrations that appear to be consistent with estimated concentrations calculated for other SDUs under the preferred alternative.¹¹ For example, FS Table J2.3-7 shows that Alternative E RALs would result in a post-construction surface of 23.94 micrograms per kilogram (ug/kg) for DDx, which would be above the range of estimated post-construction concentrations in other SDUs¹² (4.98 to 17.45 ug/kg) under the preferred alternative. When applying Alternative F RALs, the estimated resulting DDx concentration (10.55 ug/kg) is well

⁸ Data files were acquired from the LWG Portal, which includes natural neighbor grids for COCs (2015-03-31_Data_for_LWG_gdb_1.zip). The alternative SMAs were recreated using raster calculator and union geoprocessing functions and acreages compared to within 1 percent of EPA published values from FS report Table 3.8-1. Additionally, the produced SMA areas visually agree with FS report figures.

⁹ Note that Alternative B, D, and E RALs were applied throughout the vast majority of the Site.

¹⁰ Note that this value is considered inappropriate for PTW, as it is based on an indirect contact exposure scenario. However, this value was applied since it is lower than the Alternative D RAL of 500 ppb.

¹¹ Note that Siltronic has not verified EPA's post-construction estimates and these are assumed to be accurate.

¹² For purposes of these comments, “other SDUs” also includes the “no SDU” area of the Site.

within the range estimated for other SDUs. Similarly, applying the Alternative F RAL results in a PeCDF estimate (0.001142 ug/kg) within the range observed in other SDUs (0.000162 to 0.001253 ug/kg), whereas under Alternative E the post-construction concentration is estimated at 0.00242 ug/kg, two times above the maximum projected for other SDUs. Therefore, it appears that selection of Alternative F RALs results in post-construction concentration estimates (and therefore risk estimates) that are consistent with other SDUs for the focus COCs DDx and dioxins.

In contrast, use of Alternative F RALs is not justified for non-focus COCs when considering the estimated post-construction concentrations that inform residual risk estimates. For PCBs, the Alternative D (45.86 ug/kg)¹³ and Alternative E (31.04 ug/kg) post-construction estimates are already within the range observed in other SDUs under the preferred alternative (15.78 to 47.88 ug/kg) (see FS Table J2.3-7). Under the proposed Alternative F RALs, the estimated PCB concentration (17.84 ug/kg)¹⁴ is well below concentrations estimated for all other SDUs, with the exception of SDU6W, where elevated PAHs drive the SMA and initial PCB concentrations are quite low (40.48 ug/kg). Furthermore, the resulting estimated PCB concentration would be lower even than in SDU5.5E, where PCBs are identified as a focus for cleanup. Similarly, estimated carcinogenic PAH (cPAH) concentrations under Alternative F (49.01 ug/kg) would be an order of magnitude lower in SDU7W than the average (not spatially weighted) estimated post-construction concentrations in other SDUs (531.07 ug/kg), including SDUs where PAHs are a focus COC. Therefore, the preferred alternative does not provide meaningful or equitable risk reduction for non-focus COCs in this SDU.

Siltronic notes that Alternative F RALs are applied in just one other SDU (5.5E). In this case, PCBs are the focus COCs and the F RAL (75 ug/kg) appears to be necessary to achieve an estimated post-construction concentration (22.61 ug/kg) that does not exceed the range of post-construction concentrations calculated for other SDUs (15.78 to 47.88 ug/kg); under Alternative E, the estimated concentration is 53.19 ug/kg (see FS Table J2.3-7).¹⁵ In contrast, use of Alternative F RALs for non-focus COCs arbitrarily increases the SMA area in SDU7W adjacent to Siltronic (see above) and is not needed to achieve risk reduction consistent with other areas of the Site.

Application of RALs more appropriate for non-focus COCs results in estimated concentration reductions consistent with other SDUs in the Site. EPA should apply Alternative D or E RALs for non-focus COCs in SDU7W, or extend SDU6W to include the entire Siltronic shoreline.

The use of D or E RALs more appropriate for non-focus COCs would reduce the projected active remedy area that is unrelated to the focus COCs. Remediation would be more cost-effective and Alternative F RAL application for non-focus COCs is not needed to achieve risk reduction consistent with other SDUs. In fact, applying Alternative D or E RALs for non-focus COCs results in estimated post-construction concentrations consistent with all other Site SDUs, based on FS Table J2.3-7:

¹³ It is unclear if the PCB PTW level (200 ppb) or the Alternative D RAL (500 ppb) was applied in deriving this estimate. The estimate would be even lower if the calculation did not account for the PCB PTW level.

¹⁴ This is assuming that such a low level of PCBs (i.e., 17.84 ug/kg) could even be achieved, given considerations such as dredging residuals and background equilibrium concentrations.

¹⁵ Note that in FS Table J2.3-7, the estimated post-construction PCB concentration for SDU6.5E for the preferred alternative (26.16 ug/kg) appears to be an error. This concentration was not calculated for any of the alternatives.

Non-Focus Chemical of Concern ^a (ug/kg)	Estimated Post-Construction Concentrations		
	Alt I SDU ^b Range (not Including SDU7W)	Alt D (SDU7W)	Alt E (SDU7W)
Aldrin	0.16-3.45	1.35	0.92
BEHP	62.47-544.19	284.57	257.18
Chlordane	0.53-4.1	2.89	1.88
cPAHs	28.28-2659.52	187.34	146.07
Dieldrin	0.19-3.71	1.51	0.86
PCBs	15.78-47.88	45.86	31.02
NOTES: Adapted from EPA FS Table J2.3-7. BEHP = Bis 2-ethylhexyl phthalate. ^a Does not include DDx and dioxins. ^b Includes the "no SDU" Site area.			

Applying Alternative F RALs for the focus COCs would result in post-construction concentration estimates that are consistent with other SDUs, since all marginally elevated areas would be targeted, and would ensure that collocated and closely related chemicals (i.e., DDE, DDD, DDT, other dioxins) are actively remedied. In addition, using Alternative F RALs for focus COCs would further reduce the Alternative D and E estimated concentrations for non-focus COCs shown in the table above. This is because a combined focus-COC-based Alternative F and non-focus Alternative D or E SMA footprint is larger than the SMA footprint based on just the Alternative D or E RALs (see Figure 4). In summary, a combined focus-COC-based Alternative F and non-focus Alternative D or E RAL application results in no substantial change to the SMA between RM 6.8-7.5W. The unwarranted increase of SMA areas up- and downriver of this area due to non-focus COCs would be avoided, while attaining equitable estimated risk reduction and avoiding use of standards that are inconsistent with the rest of the Site.

Alternatively, EPA could extend the SDU6W boundary to include the entire Siltronic shoreline (RM 6.4-6.8W). In this way the more appropriate Alternative D RALs would be applied for all COCs in the RM 6.6-6.8W portion. Note that FS page 3-9 states, "The highest DDx concentrations are found primarily at RM 6.6-7.8W." However, this is not the case: DDx concentrations are highest at RM 6.8-7.5W (see FS Figure 3.4-12). The enlarged boundary would also capture the extent of the elevated PAHs in the northern (downriver) portion of SDU7W, as shown in Figure 4. As described above, this approach would also avoid identifying large cleanup areas for DDx and dioxins, which are neither associated with Siltronic operations nor significantly elevated along its shoreline.

It is important to note that either of these approaches would also avoid the unwarranted designation of much of the Siltronic shoreline for riverbank remedy (see Primary Issue 2) under EPA's current FS framework, since the in-water SMAs would be significantly reduced and would not extend to the shoreline.

PRIMARY ISSUE 4—GASCO-RELATED SEDIMENT RECONTAMINATION POTENTIAL

Issue Description

As shown on Figures 19a and 19d in the PP, active remediation, including dredging and capping, is identified for most of the Gasco-related SDU6W. There is potential for recontamination of the remedy due to ongoing and uncontrolled migration of subsurface PG&C NAPL from the uplands, particularly offshore of Siltronic.

Comments

PG&C NAPL is present in the subsurface at the Gasco site. EPA needs to integrate upland source control with in-water remedy to avoid sediment recontamination.

In the mid-1940s, NWN's predecessor, PG&C, developed a waste-disposal system, which included effluent ponds and a waste lagoon, on both sides of the current NWN/Siltronic property line (see Figure 6). Waste materials, including heavy and light oils, tars, emulsions, and other products from refining; gas manufacturing; and chemical production including solvents, pesticides, creosote, cyanides, and pitch, were disposed of. The estimates of the volume of wastes stored in these ponds range from approximately 6MM gallons to 32 MM gallons.^{16,17}

Today, light NAPL and dense NAPL (DNAPL) are present throughout the subsurface within and beyond the footprint of the former waste lagoon and effluent ponds. DNAPL has been observed entering wells screened as deep as 145 feet below ground surface.¹⁸ Figure 6 indicates the DNAPL thickness measured in various wells on the Siltronic property. The thickness levels fluctuate significantly over time, showing the dynamic state of the DNAPL (see Figure 7). NAPL is also present in the sediment offshore at depths of up to 16 feet below the mudline.¹⁹ NAPL continues to discharge to the Willamette River, and ebullition of NAPL to the surface water column is ongoing.

Upland source control measures (specifically, the hydraulic control and containment, or HC/C, system) are in place and appear to be capturing contaminated groundwater. However, the HC/C system is not intended to control the flow of NAPL from the upland to the river; in fact, it is specifically designed not to mobilize NAPL. The HC/C system includes DNAPL monitoring provisions to assess the long-term effects of system operations on DNAPL migration, but does not include the capacity to recover substantial quantities of DNAPL,²⁰ let alone the estimated millions of

¹⁶ HAI. Remedial investigation report, NW Natural Gasco Facility, 7900 NW St. Helens Road, Portland, Oregon. Hahn and Associates, Inc., Portland, Oregon, April 30, 2007.

¹⁷ MFA. Remedial investigation report, Siltronic Corporation facility, 7200 NW Front Ave, Portland, Oregon. Maul Foster & Alongi, Inc., April 16, 2007.

¹⁸ HAI. Summary report—former MGP operations and dense non-aqueous phase liquid occurrence. Figures 8-10. Hahn and Associates, Inc., Portland, Oregon, November 7, 2005.

¹⁹ Anchor. Draft engineering evaluation/cost estimate, Gasco sediments cleanup site, Figure 2.5.3-1. Anchor QEA, Portland, Oregon, May 2012.

²⁰ Anchor. Hydraulic control and containment system capture performance monitoring plan, NW Natural Gasco site. Anchor QEA, Portland, Oregon, May 2015.

gallons released to the subsurface during wastewater disposal prior to Siltronic's purchase of the property. There are no existing or planned source control measures to address migration of NAPL from the upland to the river. Based on the continued discharge of NAPL to the river, recontamination of sediment remedial components—such as caps—is likely to occur, absent upland NAPL source control.

It is important that EPA and DEQ work with NWN and Siltronic to develop and implement upland source control for groundwater and NAPL that is integrated with the active, in-water remediation and any riverbank work. These actions should be consistent with ongoing facility operations and acknowledge the continued migration of NAPL in the subsurface and below the river, and ideally should be implemented ahead of the sediment remedy. The goal of the coordination of the upland and sediment remedies would be to minimize costly additional future actions that would be required if recontamination occurred.

Because there are operational restrictions at the Siltronic site, it appears that only in situ remedial technologies that focus on stabilization or solidification of the manufactured gas plant (MGP) waste DNAPL are likely to meet National Contingency Plan criteria for effectiveness, protectiveness, implementability, toxicity reduction, and cost.

PRIMARY ISSUE 5—WASTE DETERMINATION

Issue Description

Waste disposal considerations are discussed in Section 3.4.9.1 of the FS report. MGP waste is identified as a "Waste or Media containing Waste that May Warrant Additional Management," and the report notes that these wastes may be specially managed as a nonhazardous waste at a Subtitle C or Subtitle D facility, based on results of toxicity characteristic leaching procedure (TCLP) testing for "MGP-related constituents." PG&C activities were not limited to the production of manufactured gas and, as a result, PG&C waste likely contains hazardous substances from those additional processes, such as waste from creosote production, coking, and chemical and pesticide formulation. Siltronic believes that testing only for MGP-related constituents is insufficient to accurately characterize the full range of hazardous substances that may be present in or commingled with PG&C waste NAPL offshore of the Siltronic site.

Comments

Siltronic is concerned that misclassification of manufacturing activities at the former PG&C (Gasco) facility may result in mischaracterization and improper management and disposal of sediment. EPA should require proper characterization and sampling to avoid improper disposal.

Historical PG&C operations included coking, petroleum refining, chemical production, pesticide production, creosote and pitch production, and other non-manufactured gas operations. Waste from these operations was discharged directly to the Willamette River from the beginning of operations until 1941, when unlined lagoons were constructed to allow the wastes to infiltrate to the upland subsurface. As a result, environmental media, including sediments, impacted by PG&C waste are not

solely MGP waste. Characterization of these wastes should recognize the known or likely presence of non-MGP constituents that are potentially present in sediments and PG&C waste NAPL.

The waste disposal narrative in the FS indicates that if Gasco MGP waste is found to be commingled with spent halogenated solvents from the Siltronic site, "the material will be classified as a RCRA listed hazardous waste for management and disposal purposes." This narrative is problematic for the following reasons:

- 1) PG&C waste is not solely waste from MGP production. It includes refinery waste, creosote and pitch production waste, and likely other waste streams as well, which will require appropriate management and disposal consistent with ARARs (applicable or relevant and appropriate requirements) for those waste streams.
- 2) DEQ administratively determined that accidental releases of trichloroethene (TCE) from Siltronic operations were to be managed as a listed, F002 hazardous waste without certainty as to the exact source of the accidental release. While Siltronic objects to the characterization of TCE as a listed waste due to uncertainty as to the source of accidental release of TCE, it would be arbitrary and capricious to fail to apply the same standard to the PG&C waste originating from the former waste lagoon on property now owned by Siltronic, or pesticide waste located in the same area. EPA should apply the same criteria for identifying all waste streams in the Portland Harbor, and should not select a listed waste criterion in the absence of certainty for one party, while overlooking significant factual and regulatory management for other wastes.
- 3) While TCE degradation products (dichloroethene isomers and vinyl chloride) are present in groundwater and TZW, these chemicals are not spent solvents, nor are they listed (F002 wastes). Groundwater, sediment, and TZW offshore of Siltronic are impacted by TCE only in a limited area where TCE is trapped in PG&C MGP NAPL in the sediment. A consistent regulatory application would characterize PG&C MGP NAPL in this area as F037 waste. Elsewhere offshore of Siltronic, groundwater and TZW are not impacted by TCE.
- 4) Groundwater and TZW offshore of Siltronic are impacted by pesticide-related wastes (dichlorobenzenes) as well. TCLP testing of sediment for pesticide-related constituents should be incorporated into sediment management plans to confirm the presence or absence of P- and U-listed waste, in order to support proper management and disposal consistent with ARARs.

Siltronic requests that EPA revisit the operational history of PG&C so that wastes discharged to the river from the former PG&C property can be properly classified, or confirm that the uncertainty associated with TCE releases from Siltronic requires management of TCE-impacted environmental media as possibly characteristic (i.e., not listed) waste when generated during remediation.

PRIMARY ISSUE 6—DESIGN AND IMPLEMENTATION FLEXIBILITY

Description

Implementation of remedies across a site as large and physically and chemically diverse as the Site will require complex designs for sediment at a much more refined scale than was considered in the FS and PP. The FS and PP appear to be overly prescriptive in remedial technology selection. Remedial means and methods should not be dictated in the PP or ROD, because additional predesign information is necessary to develop a design with the right balance of implementability, efficiency, effectiveness, and environmental protection.

Comments

There appears to be some inconsistency in the EPA FS and PP regarding how additional data and information will be applied in remedial design. EPA should provide a consistent message allowing for site-specific information, including data collected after the ROD is issued, to inform remedial design and the selection of technologies.

Siltronic would like to confirm that EPA will not require use of the remedial technologies assigned in the FS or PP, but rather that EPA anticipates allowing selection of optimal remedial approaches, given site-specific conditions. EPA has included notes on pages 26 and 37 (of the PP), which state:

Note: The specific information associated with SMA footprints, dredging depths, estimated volumes of dredged material and cap material, and thickness of caps and/or types of cap layers are assumptions for purposes of developing cost estimates for the remedial alternatives. These assumptions were developed based on the existing data and will be finalized during the remedial design, after design level data to refine the baseline conditions are obtained.

Siltronic is concerned that the above note does not include a statement that also requires the reevaluation of remedial technology assignments, based on the development of environmental and engineering data post-ROD. EPA also references what appears to be highly prescriptive technology assignment flowcharts (see PP Figures 10a-d) that apply to all areas of the Site (see PP page 34). However, in subsequent Technology Assignment figures (e.g., see PP Figure 19d), the PP does include the following note:

Note: Technology assignments are conceptual for FS evaluation purposes and assignments will be refined during remedial design.

This clarification is critical for ensuring that individual sediment remedies are developed that are both protective and constructible, based on the contaminant characteristics (concentration, nature, extent, etc.) and physical characteristics of the existing riverbed (slopes, scour conditions, groundwater context, grain size) and should specifically be included in the text of the ROD. Siltronic anticipates generation of significant new and updated site information that should be used to reassess the optimal remediation approach. The ROD should carry forward the statements that “the most appropriate and effective method to remove sediment and riverbank soils will be determined during remedial design

(see PP page 28)” and/or “the most appropriate and effective equipment will be determined during the design phase and used during construction (see FS page 3-21).” Additionally, the ROD should state that the resulting technology assignment footprints should be refined by site-specific evaluations for existing conditions, technology effectiveness, and/or implementability.

Siltronic recognizes that the decision trees that were prepared for the FS and carried to the PP as Figures 10a through 10d provide for a level of consistency in how EPA made technology assumptions for the purposes of cost estimating. However, these decision trees do not allow designers to confirm that the technology is feasible on a site-specific basis, from both an engineering and regulatory standpoint. To address this, Siltronic supports the development of a simplified decision tree for the predesign technology assignments that provides a clear and effective roadmap for design demonstrations based on site-specific conditions, as shown in Figure 8.²¹

Siltronic recommends that, rather than assigning remedial technologies in the ROD, EPA provide performance goals for each of the remedial designs—for example: “extent of contamination shall be accurately mapped to facilitate efficient removal”; “sediment removal prisms shall be designed to accurately reflect the horizontal and vertical extent of contamination and incorporate the physical conditions of the site”; “implementation methods shall be used that do not cause routine exceedance of water quality standards”; “sediment removal design shall implement dredging best management practices (BMPs) to limit the generation of residuals,” as described in U.S. Army Corps of Engineers guidance.²² Such performance goals would help ensure that sufficient flexibility is retained and appropriate and effective remedy techniques can be implemented.

The FS cost estimates do not appear to accommodate various means and methods for sediment remedy and assume a remedy approach that would be ineffective and lead to slope destabilization.

While the FS text indicates that fixed-arm, closed-bucket dredging is appropriate for water depths of less than 40 feet (see page 3-22), the FS cost estimates for Alternative I assume that cable bucket clamshell dredging accounts for 94 percent²³ of all dredging to be conducted. The intermediate and shallow zones offshore of Siltronic cannot be dredged using a cable bucket clamshell. The very steep in-water slope of 2H:1V from an elevation of -37 feet transitions to a 7H:1V shallow zone at elevation +4 feet, then rises from an elevation of +10 feet to +30 feet at a 1.7H:1V slope. In this situation, a significant upslope shoring system and fixed-arm precision dredge would be required to avoid slope destabilization and achieve effective shallow sediment removal (see Figure 2). Further, the backfill of this steep in-water slope likely will require a significant riprap armoring system to maintain this steep angle over unconsolidated backfill material. Note that this type of dredging remedy likely would cost four to eight times more than what was estimated in the FS. The method of construction is critical to the ultimate success of the remedy, is highly location-specific, and is a significant cost variable.

EPA provides a very limited selection of dredging BMPs (including turbidity curtains, sheet-pile walls, and daily residuals layers) to control the release of contaminants during

²¹ This figure is a modified version of a forthcoming Lower Willamette Group PP Comments figure.

²² COE. Technical guidelines for environmental dredging of contaminated sediments. U.S. Army Corps of Engineers, September 2008.

²³ See Table CS-I. Approximately 1.56 million cubic yards (cy) of a total of 1.65 million cy are assumed to be dredged with cable bucket.

construction, when alternatives that are more appropriate or effective are available. The ROD should state that remedy design will incorporate appropriate dredging and water quality BMPs to minimize and control the release of contaminants from the work area, and that remedy construction will implement monitoring routines to verify that design goals and permit conditions are met.

The PP specifies that turbidity curtains and sheetpile walls will be used as dredging BMPs to control the release of contaminants from the work area. Both turbidity curtains and sheetpile walls are work area isolation techniques that are typically employed as water quality BMPs. EPA should expand the definition of dredging BMPs to include a combination of operational controls (fully closing buckets, slow bucket movement near the mudline, prohibition of multiple grabs at a dredge target, etc.); design controls (refined dredge prism sampling, stepped cuts for progressively deeper removal targets, specifying the sequencing of work and BMP implementation to prevent recontamination of recently remediated areas, etc.); and potential work area isolation strategies, as needed.

In addition, the PP requirement that a daily residuals layer be placed in all active dredge areas (page 8 of the PP) may not be practically implementable or environmentally responsible. This BMP would reduce dredging efficiency by more than 25 percent. Further, the daily residuals cover will have to be removed at the start of each day and will have to be disposed of with contaminated sediments. The inefficiencies and additional disposal are not considered in the FS cost estimates, nor is this approach an environmentally responsible practice. The most appropriate dredge residuals management approach should be developed during design to reflect the selected dredging method, operational dredging BMPs, elevation of target contamination, hydrodynamic and geotechnical environment, and post-remedy performance requirements.

CONCLUSIONS

Siltronic appreciates the considerable time and effort spent by the EPA in developing the PP for the Site. Siltronic looks forward to working with EPA on an effective, implementable cleanup that protects both human health and the environment.

Siltronic is in a unique situation in that the environmental legacy of the property was unknown when the property was purchased, and the property is adjacent to two SDUs for which the risk-driving focus COCs are unrelated to Siltronic operations. For SDU7W, EPA has proposed use of RALs with consequences that likely are unintended, including a significant increase of the active remedy area that does not provide warranted or equitable risk reduction. Furthermore, the riverbank has not been sufficiently characterized to warrant a “known contaminated” designation, and the combination of upland infrastructure, presence of PG&C NAPL, and steep nearshore bathymetry presents significant constraints in the evaluation of implementable cleanup actions. The comments provided here present the issues that have significant implications for Siltronic and other affected properties, including showing how they are critical to achieving an effective cleanup, and provide solutions for EPA’s consideration. Siltronic’s primary comments are summarized below:

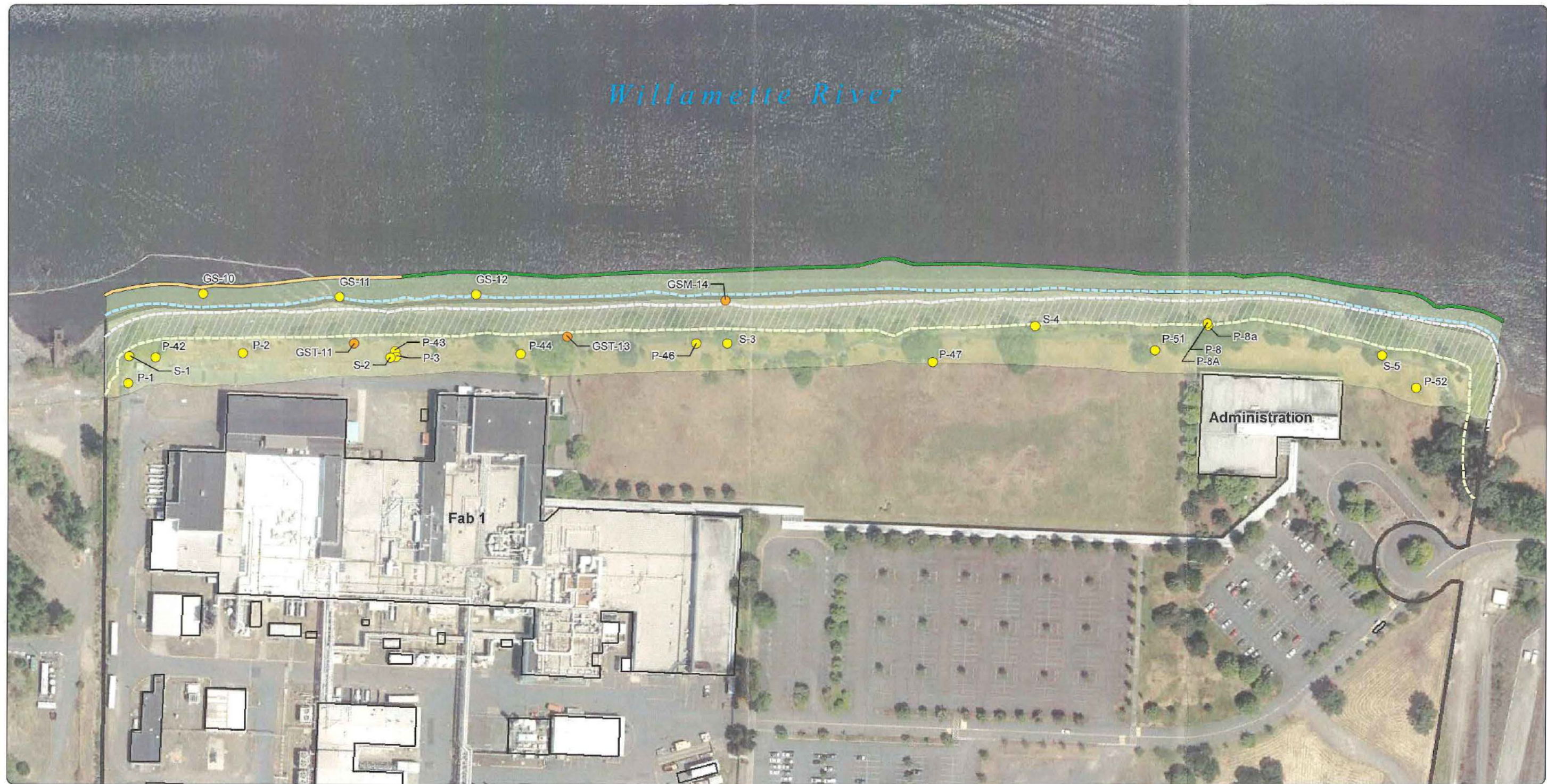
- **“Known Contaminated” Riverbank Designation.** The entire Siltronic riverbank is not known to be contaminated and the riverbank erosion pathway is incomplete; the “known contaminated” designation should be removed;

- **Riverbank Remedy Assessment.** If RAO 9 is carried forward, EPA should provide a framework that includes characterization to determine the need for remedy and that allows for a remedy alternatives evaluation;
- **SMA Extent in SDU7W.** Application of appropriate RALs would avoid an unwarranted increase of active remedy due to non-focus COCs, while attaining equitable risk reduction and avoiding use of standards that are inconsistent with the rest of the Site;
- **Gasco-Related Sediment Recontamination Potential.** To avoid sediment recontamination, it is important that EPA and DEQ work with NWN and Siltronic to develop upland source control for groundwater and NAPL before the in-water remedy is constructed;
- **Waste Determination.** EPA should require proper waste disposal sampling and characterization to avoid misclassification of creosote production, petroleum refinery operations, and chemical manufacturing waste from the former PG&C facility; and,
- **Design and Implementation Flexibility.** Remedial means and methods should not be prescribed, because additional predesign information is necessary to develop a design with the right balance of implementability, efficiency, effectiveness, and environmental protection.

Siltronic urges EPA to account for these important issues in the FS or the ROD. Doing so will help deliver the balance of vision and flexibility needed for this complex Site and ensure that all river uses are successfully protected.

FIGURES





Source: Aerial photograph obtained from Esri ArcGIS Online; site boundary tax lots (2016) obtained from Metro RLIS (Regional Land Information System).

Notes:
1. Top of Bank, Toe of Slope, and Ordinary Low Water locations are approximate.

MAUL FOSTER ALONGI
p. 971 544-2139 | www.maulfooster.com

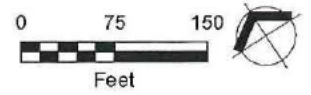
This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

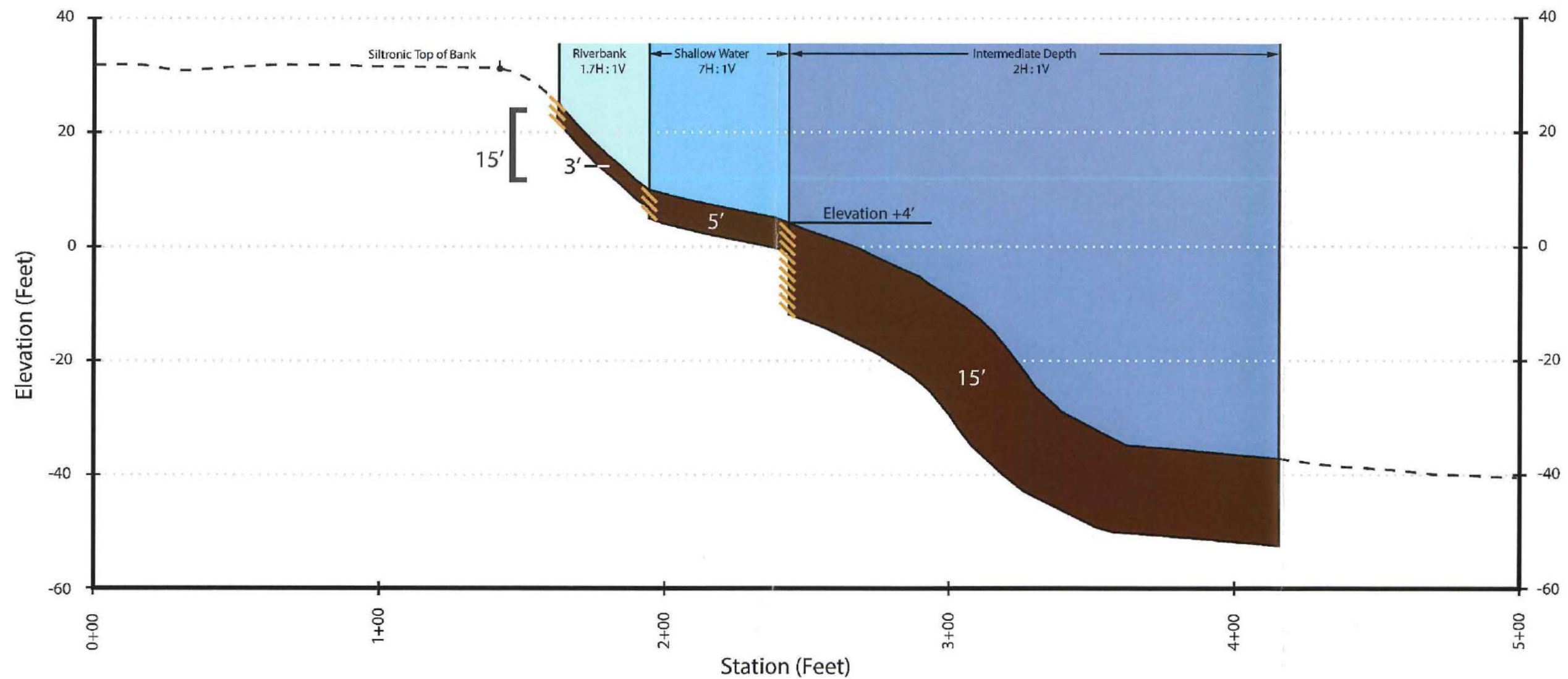
- Legend**

 - Site Boundary
 - Surface Soil Sample, EPA FS Database, Appendix A
 - Other Surface Soil Sample
 - Top of Bank
 - Toe of Slope
 - Ordinary Low Water
 - Bank Area
 - Segment 3 (DEQ Designation)
 - Segment 1 (DEQ Designation)
 - 150-ft Buffer Area

Notes (cont.):
2. Surface soil = 0 to 5 feet below ground surface.

Figure 1
Riverbank Surface Soil Sample Locations
Siltronic Corporation
Portland, Oregon





Legend

- EPA Proposed Maximum Excavation Depth
- Slope Destabilization Area

Figure 2
Riverbank and In-Water
Slope Zones

Siltronic Corporation
Portland, Oregon



Source: Aerial photograph (2011) and site boundary tax lots (2016) obtained from Metro RLIS (Regional Land Information System).

Notes:
1. Areas shown as depicted in EPA's Proposed Plan 2016.
2. See text for discussion of GIS methods.

- Legend**
- Navigation Channel
 - SDU6W and SDU7W
 - Alternative D
 - Alternative F
 - Taxlots

MAUL FOSTER ALONGI
p. 971.544.2139 | www.maulfooster.com

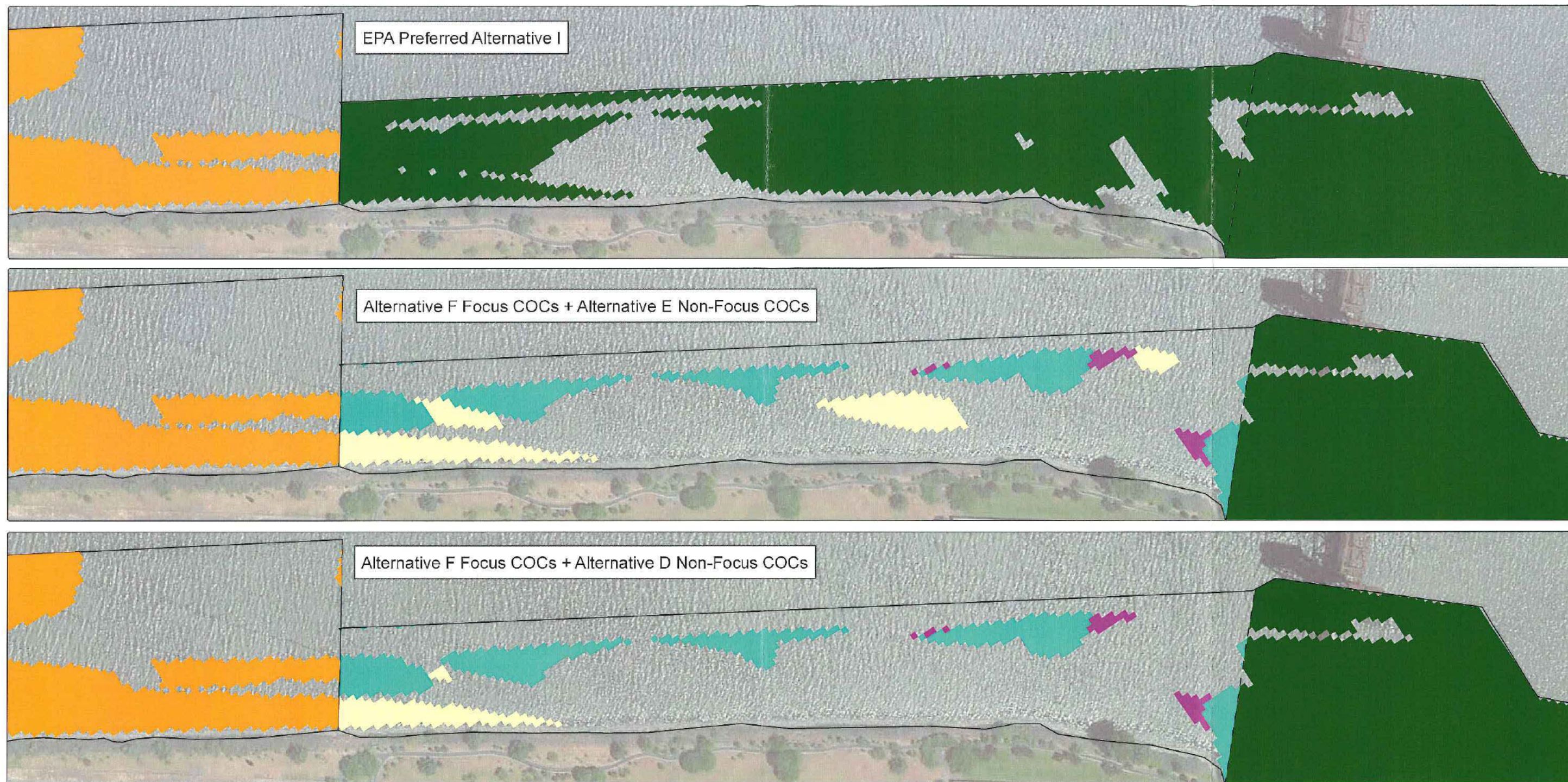
This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Figure 3
Sediment Management Area
SDU6W and SDU7W

Siltronic Corporation
Portland, Oregon



Path: X:\6126.02 Siltronic Corp\0302\Projects\Fig4 - SDU7W Sediment Management Area, RM 6.6 to 6.8.mxd
Print Date: 6/31/2016
Approved By: P. Wessler
Produced By: apadilla
Project: 6126.02.03.03



Source: Aerial photograph obtained from Esri ArcGIS Online; site boundary tax lots (2016) obtained from Metro RLIS (Regional Land Information System).

- Notes:
1. Alternative I Areas shown as depicted in EPA's Proposed Plan 2016.
 2. See text for discussion of GIS methods.

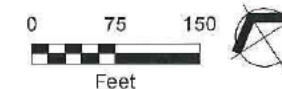
 **MAUL FOSTER ALONGI**
p. 971 544 2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.



- Legend**
- River Mile Tenths
 - SDU6W and SDU7W
 - Alternative D
 - Alternative F
 - Alternative F Dioxins, DDx
 - PAH
 - PCB (PTW)

Figure 4
SDU7W Sediment Management Area (RM 6.6-6.8)
Siltronic Corporation
Portland, Oregon



Project: \$128.02.03.03 Produced By: acadilla Approved By: P. Wiesner Print Date: 8/31/2016 File: X:\A128.02 Siltronic Corp\030303\Projects\Figs SDU7W Sediment Management Area_RM 6.9 to 7.8.mxd



Source: Aerial photograph obtained from Esri ArcGIS Online; site boundary tax lots (2016) obtained from Metro RLIS (Regional Land Information System).

Notes:
1. Alternative I Areas shown as depicted in EPA's Proposed Plan 2016.
2. See text for discussion of GIS methods.

 MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

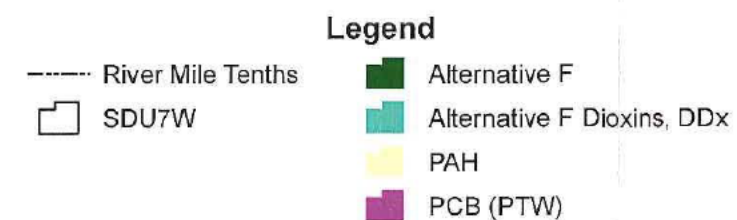


Figure 5
SDU7W Sediment Management Area (RM 6.9-7.8)
Siltronic Corporation
Portland, Oregon

0 75 150
Feet



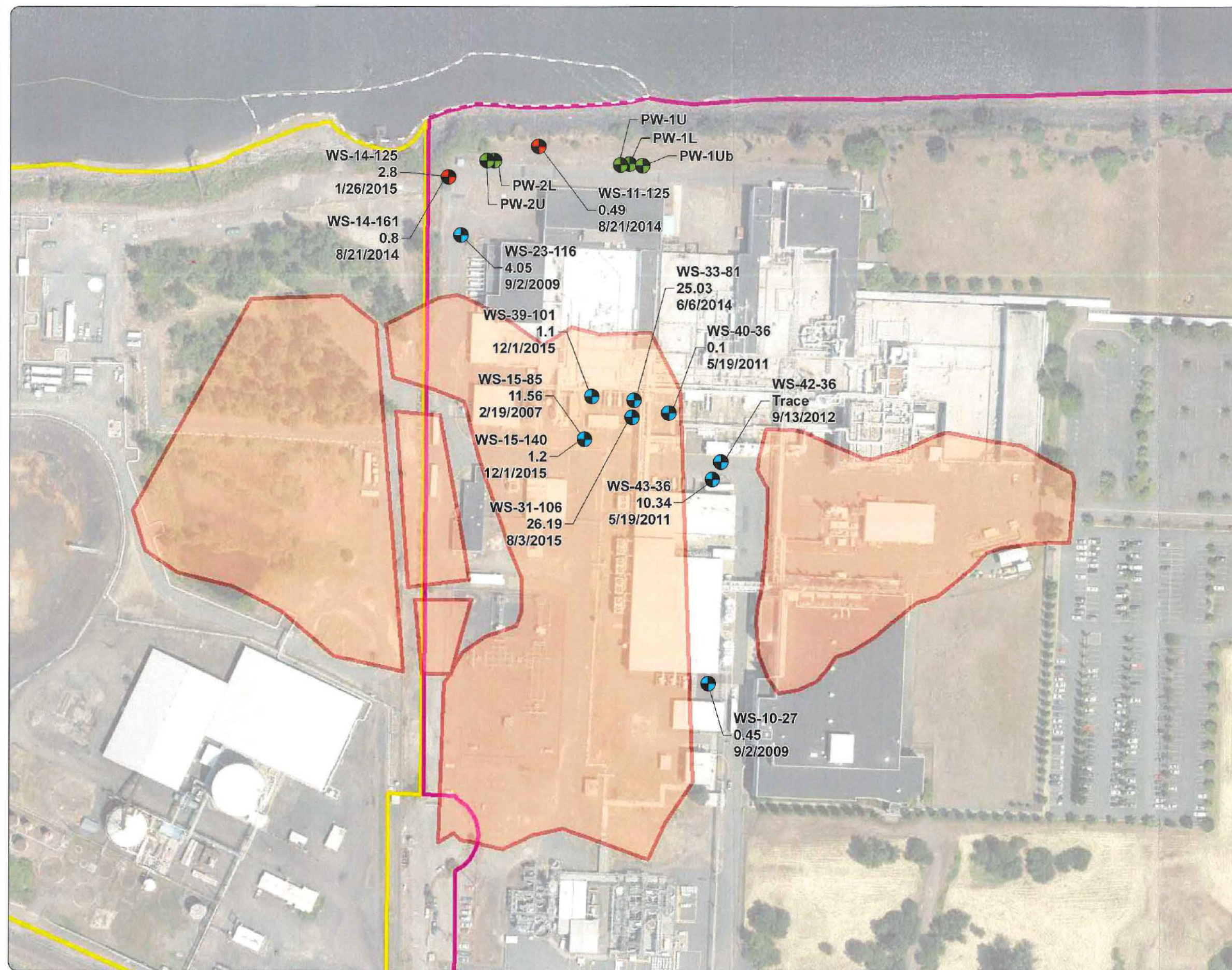


Figure 6
DNAPL Thickness
Measurements in
Wells Located on
Siltronic Property

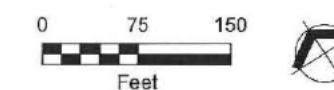
Siltronic Corporation
Portland, Oregon

Legend

- NW Natural Pumping Well
- Siltronic Monitoring Well
- Decommissioned Siltronic Monitoring Well
- Portland Gas & Coke Historical Waste Disposal Areas
- Sheen Monitoring Area
- Siltronic Site Boundary
- NW Natural Site Boundary

WS-22-81 (Well ID)
25.03 (Max Observed DNAPL Thickness (feet))
6/6/2014 (Date of Max Observed DNAPL Thickness)

- Notes:
1. DNAPL = dense nonaqueous-phase liquid.
 2. PW-1Ub location is approximate.



Source: Aerial photograph (2014) and site boundary (tax lot, 2015) obtained from Metro.

MAUL FOSTER ALONGI
p. 971.544.2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

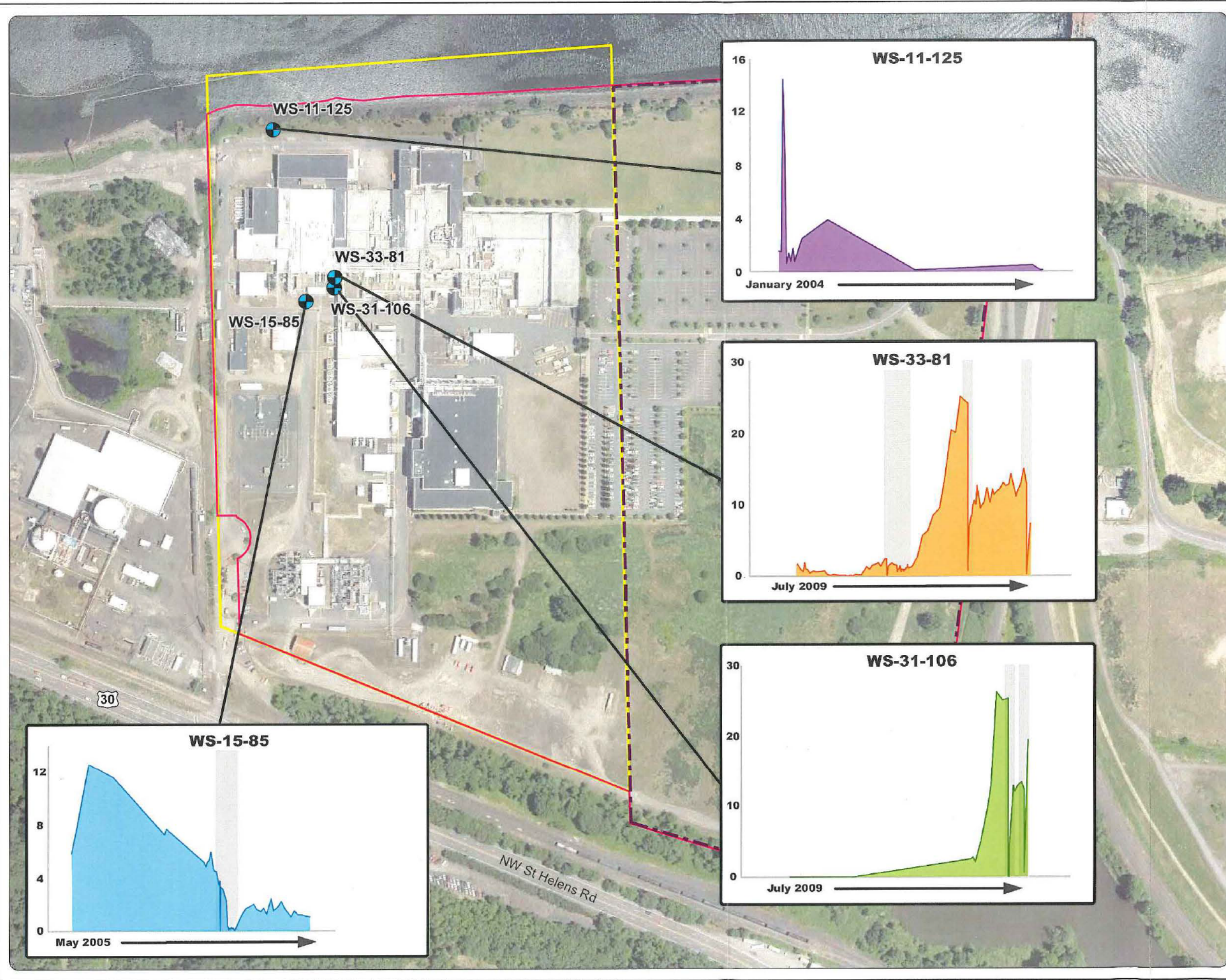


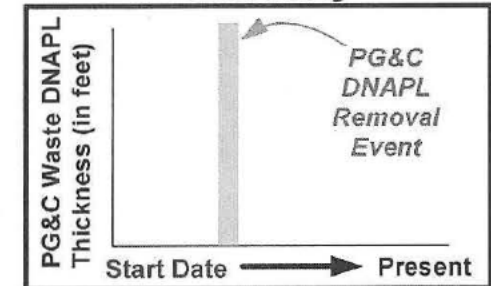
Figure 7
PG&C Waste DNAPL
Fluctuation Over Time

Siltronic Corporation
Portland, Oregon

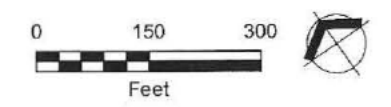
Legend

- Monitoring Well
- Allen Tract Boundary
- Siltronic OU
- Siltronic Property

Chart Key



- Notes:
1. PG&C = Portland Gas & Coke
 2. DNAPL = dense nonaqueous-phase liquid.



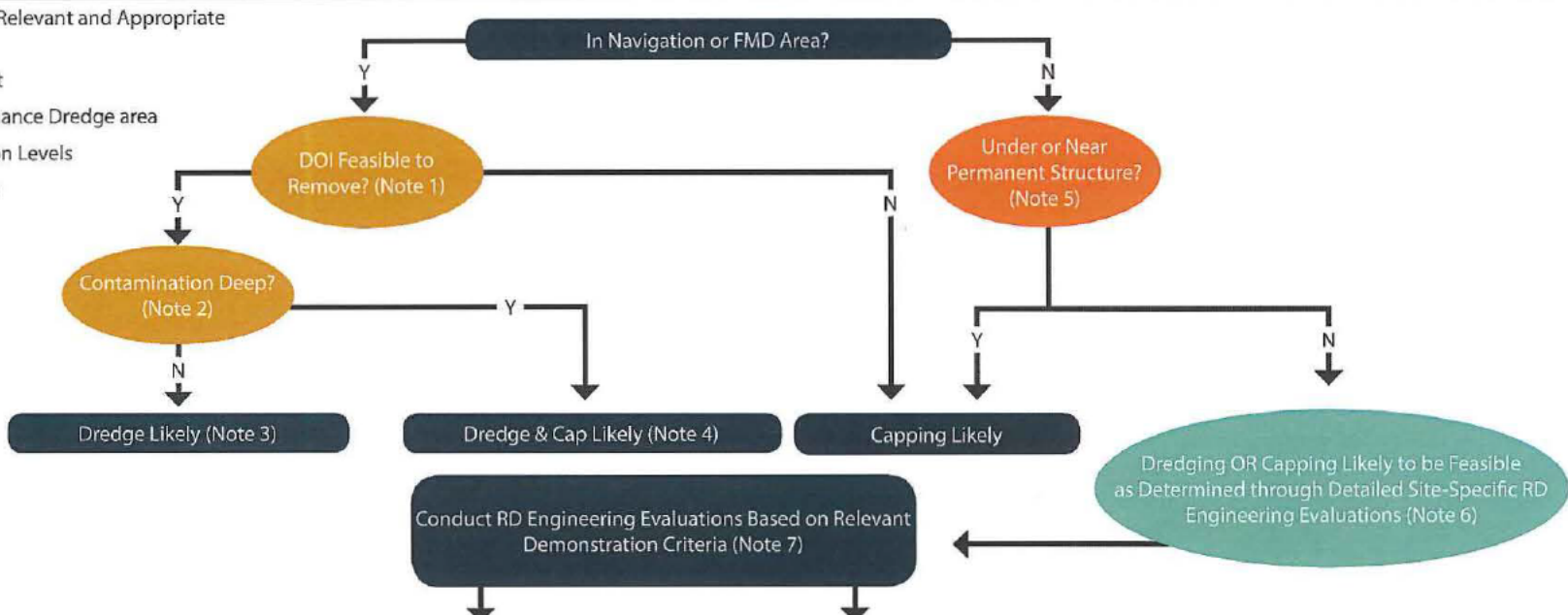
Source: Aerial photograph obtained from Esri
ArcGIS Online

MAUL FOSTER ALONGI
p. 971.544.2139 | www.maulfooster.com

This product is for informational purposes only and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Path: X:\1218.02 Siltronic Corp\1302\Projects\Fig8_Technology Assignment Decision Tree.mxd
Print Date: 8/29/2016
Reviewed By: P. Wiescher
Produced By: apadilla

ARAR - Applicable or Relevant and Appropriate Requirements
DOI - Depth of Impact
FMD - Future Maintenance Dredge area
RALs - Remedial Action Levels
RD - Remedial Design



Dredging Demonstration Criteria (Note 3)	
Erosion	Demonstrate that erosional effects (from currents, propwash, or wind/waves) will not make dredging infeasible due to high sediment resuspension and release conditions. Demonstrate that any necessary dredge residual covers will not be eroded shortly after placement.
Deposition	Dredging may be conducted in high or low deposition rate areas because the contamination will be removed and subsequent deposition rates do not impact dredging effectiveness.
Shallow/Habitat	Demonstrate that the proposed dredge design will not unnecessarily alter shallow water habitats (or other habitats) in such a way that reduces habitat values (e.g., dredging of shallow areas that converts them to deep water areas). Or alternatively, that dredge habitat impacts are balanced with other remedy features such as: contaminated sediment capping in other areas that increases shallow habitat to the overall remedy, additions of habitat features (e.g., fish mix or other appropriate surface substrates after dredging), compensating on site mitigation, compensating off site mitigation, or other types of habitat impact mitigation.
Steep Slopes/Geotechnical	Demonstrate that the proposed dredge design can be constructed on any steep slopes and will not cause unstable slopes during and after dredging including adjacent riverbank and upland areas.
Rock/Cobble/Bedrock	Demonstrate that the dredging method can remove contaminated sediments intermixed with any rock, cobble, or hard substrates (e.g., are specialty or small suction dredges needed?) without substantial exacerbation of dredge resuspension and releases.
Debris	Demonstrate that debris can be effectively removed to a sufficient degree that any remaining debris will not substantially hinder the efficient removal and subsequent transloading, transport, and processing (e.g., dewatering/treatment) of the removed sediment. Demonstrate that any remaining debris will not contribute to substantially increased sediment resuspension and contaminant releases during dredging.
Flooding	Demonstrate that the proposed dredging plan will not lead to new features (abrupt edges, berms, jutting shoreline features) on the bottom or along the riverbank that could substantially alter river flows such that unacceptable water surface elevation rises are caused locally or otherwise. This can be accomplished through appropriate hydrodynamic modeling if such features are present in the design.
Containment	Although dredge residual covers are not intended to "contain" residual contamination, demonstrate that any such covers necessary will be present and available for natural intermixing with surface sediments over a reasonable period of time (i.e., covers will not be quickly eroded downstream under typical flow conditions).
DOI	Demonstrate that the DOI can be effectively removed by the dredging equipment proposed while providing stable side slopes. If the DOI cannot be completely removed, demonstrate that any remaining contaminated material can be effectively capped by meeting all of the capping demonstration criteria as applied to the new depth horizon created by the proposed dredging.

Capping Demonstration Criteria (Note 8)	
Demonstrate that the cap will remain in place when subjected to current, wave, and propwash induced forces up to a reasonable design condition (e.g., 100 year flow event for currents).	
Capping may be conducted in high or low deposition rate areas because caps must demonstrate effectiveness even in zero deposition or erosional conditions (see erosion criterion). Additional deposition on top of a cap only improves the cap effectiveness over time.	
Demonstrate that the proposed cap design will not unnecessarily alter shallow water habitats (or other habitats) in such a way that reduces habitat values. Or alternatively, that cap habitat impacts are balanced with other remedy features such as: contaminated sediment or riverbank dredging in other areas that increases shallow habitat to the overall remedy, additions of habitat features (e.g., fish mix or other appropriate surface substrates), compensating on site mitigation, compensating off site mitigation, or other types of habitat impact mitigation.	
Demonstrate that the cap will remain in place on the existing slope through appropriate design evaluations and additional design features (e.g., keying in the cap at the foot of the slope or using more granular material in some layers) as necessary. This should include evaluating seismic events of reasonable design magnitude. Demonstrate that the sediment bed geotechnical properties will adequately support the proposed cap.	
Capping of contaminated sediments intermixed with any rock, cobble, or hard substrates can be conducted in most cases because placement of sand or similar material is not affected by the presence of such hard substrates. Erosion demonstration criterion must also be met if hard substrates occur in high energy areas.	
Demonstrate that the debris does not present a substantial obstruction to effective capping of the area (e.g., such that large voids are not created by overlying timbers or complex debris fields). Or alternatively, that the sufficient debris removal prior to capping is incorporated into the design such that the cap can be effectively placed.	
Demonstrate that cap will not cause an unacceptable flood rise in conjunction with the overall remedy for that area. This can be accomplished through balance cut and fill calculations or appropriate hydrodynamic modeling that considers capping and dredging in adjacent or nearby areas.	
Demonstrate through cap modeling consistent with guidance that the cap design is sufficient to contain and minimize flux of contaminants over a design life consistent with guidance. This would include incorporation of "active" cap features such as organoclay and activated carbon as indicated necessary by modeling runs. The modeling would consider not only the contaminated sediment properties and concentrations but also the presence of any ongoing, stranded, or uncontrolled upland groundwater plumes. The cap design and modeling runs should appropriately incorporate the in-river conditions (good or bad) created by any ongoing or planned upland groundwater source controls.	
Any DOI can be capped as long as the other demonstration criteria are met.	

Addressing Principal Threat Waste (PTW): If PTW is found at the Site during RD, then treatment should be accordingly incorporated into the dredge or cap designs discussed in this decision tree.

For dredging, any removed PTW would undergo appropriate treatment (e.g., cement stabilization prior to disposal). Importantly, the PTW guidance makes no requirements about disposal after treatment for PTW material, and PTW determination is not a relevant factor in disposal decisions after treatment takes place.

Post dredging residual covers may be needed as indicated by the above demonstration criteria. If so, the concentrations and conditions of the residuals should be estimated to determine whether they would independently meet the definition of PTW similar to the evaluation of any other "in place" sediments. If the residuals are estimated to meet the PTW definition, then active materials (e.g., activated carbon or other appropriate treatment media) should be added to the residual cover sand.

For capping, if a cap is proposed to remediate PTW sediments that cap must 1) meet all of the above demonstration criteria including the "containment criteria" and 2) include some "active" layers or materials to provide treatment, even if cap modeling shows that such active materials are not needed to provide complete containment.

Notes

- 1) Removal of very deep contamination may cause unstable side slopes, threaten nearby structures, or other issues. EPA used an FS-level assumption that >15 ft DOI was infeasible to remove. In RD a site specific engineering evaluation would be conducted to determine the feasible depths of removal for any given situation.
- 2) Is contamination deeper than needed or required navigation depth plus needed cap depth and any cap and navigation safety factors?
- 3) Where dredging is the selected technology, site specific engineering calculations would be conducted in RD to estimate the range of dredge residual concentrations likely in various dredge management areas. Dredge residuals management procedures such as sand covers will be determined in design based on the estimated concentrations of residuals relative to the RALs and may include addition of activated carbon to sand covers if dredge residual concentrations are expected to be relatively high or contain PTW (see PTW step at bottom of decision tree).
- 4) An RD engineering evaluation would be conducted to determine the cost effectiveness of dredging vs. possible dredge and cap back options.
- 5) The "permanence" of a structure would be determined in RD based on existing and planned future uses for such structures including potential plans for refurbishing or improving the structure to maintain existing uses or expand to additional new uses (i.e., this evaluation is not based on the perceived or actual current structural or physical integrity of the structure).

- 6) Both capping and dredging can be engineered outside the vast majority of areas outside navigation and FMD areas and away from structures. Not all of the issues often discussed completely rule out the effective design of either capping, dredging, or dredge/cap combination remedies. The most effective of these designs should be determined in RD based on site specific engineering evaluations and any new RD data collected to support such evaluations. These other issues include: debris; flood concerns; slopes; wave, current, and propwash erosion; sediment bed geotechnical stability; depositional areas, shallow areas, and habitat concerns.
- 7) The purpose of demonstration criteria is to determine whether there are any fatal flaws to either a dredging or capping (or dredge/cap combination) remediation approach and verify that the technology would be both effective and protective (including meeting ARARs). Demonstration criteria do not determine the relative cost effectiveness of the technologies, and if both technologies are demonstrated to be effective, then either approach can be used as may be appropriate considering other factors such as cost, current or proposed future site uses, habitat impacts, flood impacts, short term impacts, business concerns, logistical issues, or other feasibility issues.
- 8) The term capping may also include other types of in-situ remediation (e.g., in-situ treatment). If these other types of in-situ remediation appear preliminarily feasible, the capping demonstration criteria should be generally used but may need to be modified in some cases, particularly for the containment criterion.

NOTE: This figure is a modified version of a forthcoming Lower Willamette Group PP Comments figure.

BANCS ASSESSMENT





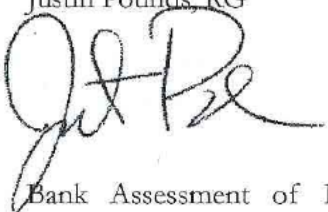
MEMORANDUM

To: File

Date: August 29, 2016

From: Justin Pounds, RG

Project: 8128.02.03

RE:  Bank Assessment of Non-point Source Consequences of Sediment at Siltronic Corporation

This memorandum presents the results of an erosion potential assessment, conducted by Maul Foster & Alongi, Inc. (MFA), of the Willamette River bank adjacent to the Siltronic Corporation (Siltronic) property in Portland, Oregon. MFA used the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) model to predict the erosion potential and channel stability of the riverbank. The BANCS model uses the quantitative assessment of the Bank Erosion Hazard Index (BEHI), developed by David L. Rosgen of Wildland Hydrology, Inc. (Rosgen, 2001). The BEHI is a procedure for assessing streambank erosion condition and potential. The U.S. Fish and Wildlife Service and the Oregon Department of Environmental Quality use the BEHI in the Portland Harbor to evaluate bank erosion potential.

ASSESSMENT METHODS

On May 5, 2016, personnel from MFA conducted a survey of the riverbank along the Siltronic property adjacent to the Willamette River to obtain the site-specific data of the current bank conditions necessary for completing the erosion assessment. The riverbank survey was conducted both on foot along the top of riverbank and in other accessible areas, as well as by boat to access the riverbank from the Willamette River.

The BEHI was assessed along 12 transects spaced at 200-foot intervals along the riverbank. Figure 1 shows the location of the 12 transects. The elevation profiles of transects 1 through 4, 5 through 8, and 9 through 12 are presented in Figures 2, 3, and 4, respectively. Representative photographs of the bank conditions are provided in Attachment 1.

To evaluate the BEHI, MFA conducted a visual inspection of the riverbank transects at high and low tide by boat to measure the following characteristics:

- Bank height

2001 NW 19th Avenue, Suite 200, Portland, OR 97209
WWW.MAULFOSTER.COM

- Bankfull height
- Root density and depth
- Type of surface protection (e.g., boulders, cobbles, sand, gravel, silt/clay)
- Vegetation
- Bank angle
- Condition of bank materials

A complete BEHI field sheet with ratings for each transect is provided in Attachment 2. The measured stream bank characteristics were converted to a risk rating system, to find the applied BEHI value for each bank characteristic (Rosgen, 2014). The assessment of the BEHI assigns point values to the following six characteristics:

1. Ratio of bank height to bankfull height
2. Ratio of root depth to bank height
3. Weighted root density
4. Bank angle
5. Surface protection
6. Bank material composition

The methods for determining each of these characteristics are described in the following subsections.

Ratio of Study Bank Height to Bankfull Height

The ratio of study bank height to bankfull height required the identification of the elevation of the top of bank, ordinary high waterline (OHW), and ordinary low waterline (OLW). The study bank height is the difference in elevation from top of bank to the OHW. The bankfull height is the difference in elevation from the OHW to the OLW.

Root Depth Ratio and Weighted Root Density

Root depth is the ratio of average plant root depth to the bank height, expressed as a percent (e.g., roots extending 10 feet into a 20-foot-tall bank = 0.50). Because of a lack of exposed roots, the root depth was estimated based on reference values for the rooting depth of the plant species present along the bank.

Root density is the proportion of the streambank surface covered by plant roots, expressed as a percent. Rooting density was estimated with the percentage of vegetation on bank. Weighted root density was found by multiplying root depth ratio and root density.

Bank Angle

Bank angle is the angle of the bank from the OLW to top of bank. Bank angle was calculated at each transect, using the elevation profile of the bank (Figures 2 through 4).

Surface Protection

Surface protection is the amount of stream bank covered by plant roots, logs, branches, rocks, etc., expressed as a percent. This was visually estimated for each transect.

Bank Material Composition

Elements of the bank material composition assessed in the field included the grain size distribution of the bank material and the presence of stratification. The bank along the entire shoreline of the Siltronic property is covered with riprap; no stratified materials are exposed in the bank. Due to the relatively uniform coverage of riprap along the bank, grain size distribution for the bank materials was measured by choosing an area (about 1 meter square) representative of the 200-foot-long bank segments between transects.

The following Bank Material Adjustment was applied in the BEHI calculation:

- Bedrock (overall very low BEHI)
- Boulders: >10 inches (overall very low BEHI)
- Cobble: 0.2 inch to 10 inches (subtract 10 points of uniform medium to large cobble)
- Gravel or Composite Matrix (add 5 to 10 points, depending on percentage of bank material that is composed of sand)
- Sand: 0.04 inch to 0.2 inch (add 10 points)
- Silt/Clay: 0.0002 inch to 0.04 inch (no adjustment)

BEHI RATING METHODS

The sum of the six bank characteristics (ratio of bank height to bankfull height, ratio of root depth to bank height, weighted root density, bank angle, surface protection, and bank material composition adjustment) was applied to the BEHI scale (Attachment 2) to determine the rating for each transect. All transects and corresponding BEHI ratings are summarized in Table 1.

The total BEHI value of each transect can be correlated with the BEHI adjective ratings on the following table:

Total BEHI	BEHI adjective rating
5-9.5	Very Low
10-19.5	Low
20-29.5	Moderate
30-39.5	High
40-45	Very High
46-50	Extreme

CHANNEL STABILITY

The channel stability characteristics were also recorded at each transect and used to assign a channel stability rating for each transect (Rosgen, 2001). The channel stability assessment categories and criteria for assigning channel stability ratings are shown in Table 2. The channel stability ratings for each transect are summarized in Table 3.

The following 15 channel stability characteristics were assessed at each transect:

1. Landform slope
2. Mass erosion
3. Debris jam potential
4. Vegetative bank protection
5. Channel capacity
6. Bank rock content
7. Obstructions to flow
8. Cutting
9. Deposition
10. Rock angularity
11. Brightness
12. Consolidation of particles
13. Bottom size distribution
14. Scouring and deposition
15. Aquatic vegetation

RESULTS

BEHI Ratings

Overall, the physical characteristics (bank material, surface protection, slope, root density, bankfull ratios, etc.) of the Siltronic bank were generally uniform at all 12 transects. BEHI results from each transect are provided in Table 1 and summarized below:

- The study bank height to bankfull height ratio was uniform with a corresponding risk rating of “moderate” (4.0 to 5.5 BEHI).
- Root depth to study bank height ratio BEHI risk ratings were “low” or “high,” depending on placement of mature trees along the top of bank (3.0 to 7.0 BEHI).
- Because of lack of vegetation along the bank, weighted root density was rated as “moderate” to “extreme” (5 to 9 BEHI).
- The bank angles (slopes) of all transects ranged from 26 degrees to 30 degrees as measured from the OLV to top of bank, and scored a BEHI risk rating of “low.”

- Surface protection was uniform along the entire bank, with approximately 95 percent coverage and a BEHI risk rating of “very low.” The approximate 5 percent of unprotected surface consists of localized sediment deposits along the OLW.
- Bank material along all transects was found to be cobbles to boulders. The presence of uniform cobbles and boulders along the entire bank resulted in the subtraction of 10 points from the total BEHI score for each transect as the bank material adjustment.

The total BEHI model scores for transects 1, 7, 9, and 12 resulted in adjective ratings of “very low.” BEHI model scores for the remaining transects resulted in an adjective rating of “low.”

Channel Stability

The channel stability characteristics were found to be generally uniform in all transects surveyed and resulted in overall channel stability scores of 42 to 48, corresponding to an overall channel stability rating of “good and stable” for all transects. See Table 3 for the channel stability summary.

REFERENCES

Rosgen, D. L. 2001. A practical method of computing streambank erosion rate. Vol. 2, pp. 9-15. Proceedings of the 7th Federal Interagency Sedimentation Conference, March 25, Reno, Nevada.

Rosgen, D. L. 2014. River stability field guide. 2d ed. Wildland Hydrology.

ATTACHMENTS

Figures

- 1 Riverbank Transect Locations
- 2 Riverbank Transects 1–4
- 3 Riverbank Transects 5–8
- 4 Riverbank Transects 9–12

Tables

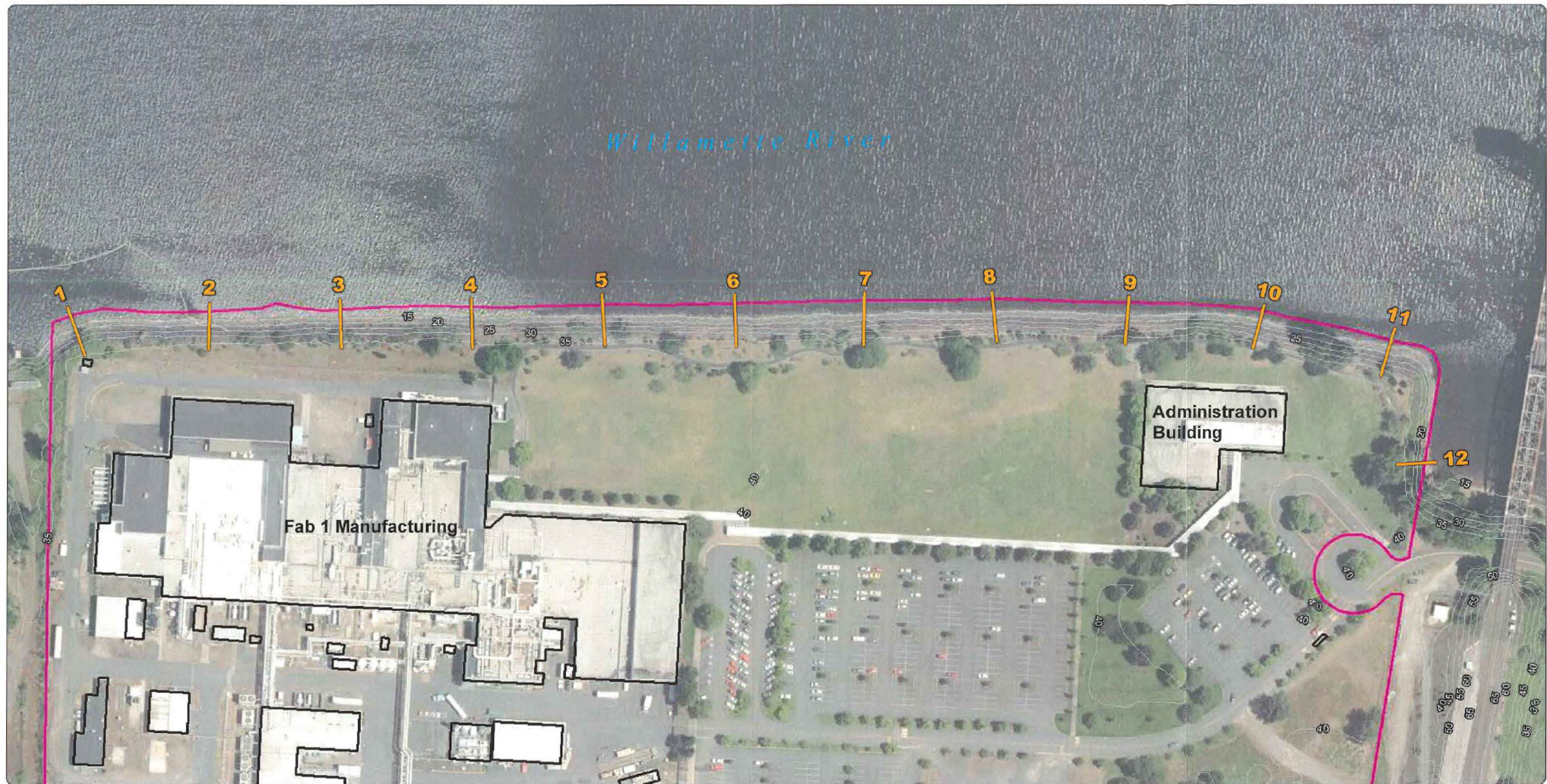
- 1 BEHI Transect Summary
- 2 Channel Stability Ratings
- 3 Channel Stability Summary

Attachment 1 Photographs

Attachment 2 BEHI Field Data Sheets

FIGURES





Source: Aerial photograph (2012) obtained from City of Portland; elevations obtained from 2005 Columbia River dataset, Puget Sound LIDAR Consortium.

Note: NAVD88 = North Americal Vertical Datum of 1988.

 **MAUL FOSTER ALONGI**
p. 971 544 2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Legend






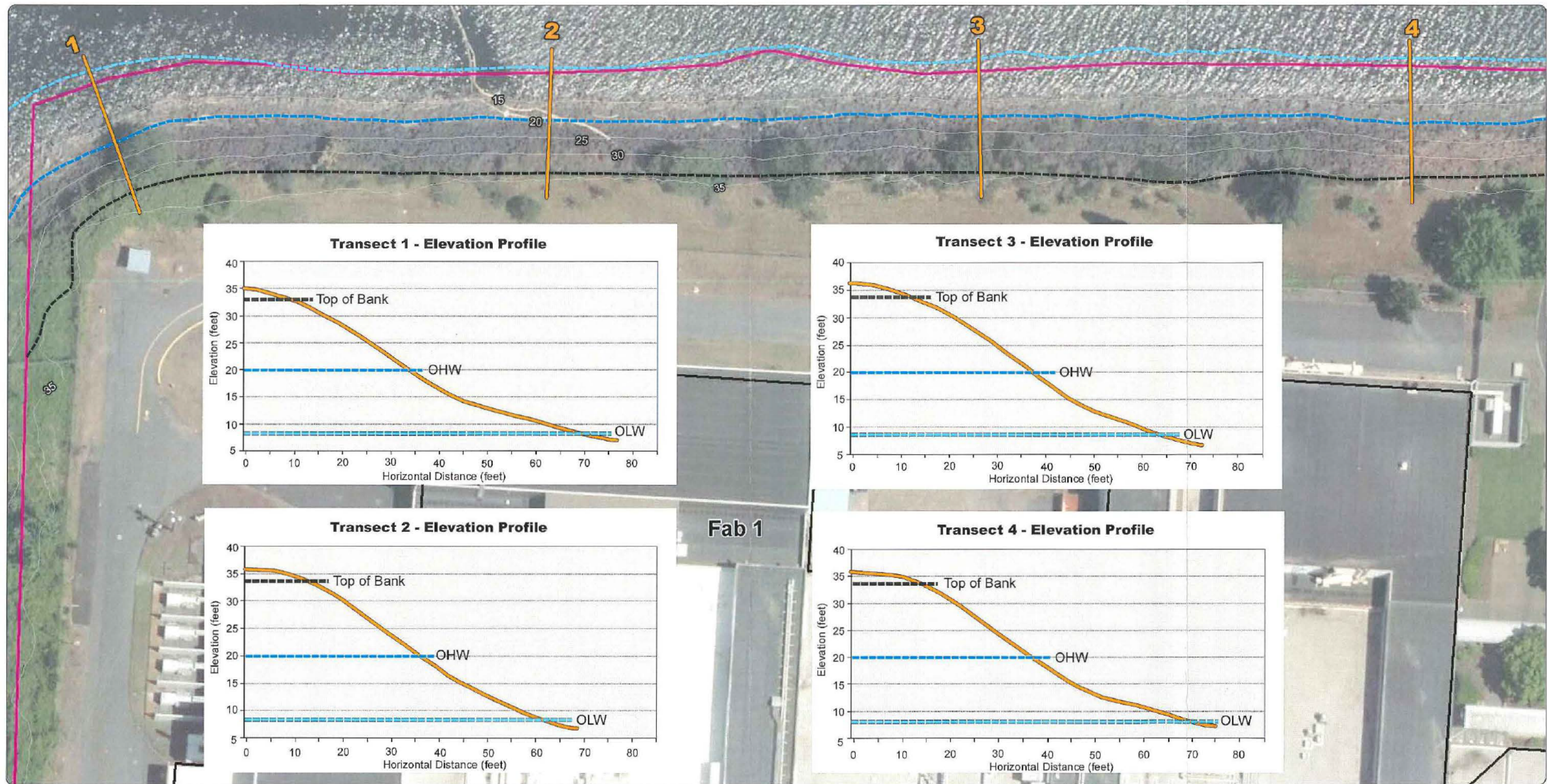
-  Riverbank Transect (with Transect ID)
-  Elevation (NAVD88, feet)
-  Photo
-  Site Building / Structure
-  Site Boundary

Figure 1
Riverbank Transect Locations
Siltronic Corporation
Portland, Oregon

0 75 150
Feet





Source: Aerial photograph (2012) obtained from City of Portland; National Flood Hazard dataset obtained from FEMA; elevations obtained from 2005 Columbia River dataset, Puget Sound LiDAR Consortium; Ordinary High Water and Ordinary Low Water data obtained from Oregon Department of State Lands.

MAUL FOSTER ALONG I
p. 971 544 2139 | www.maulfooster.com

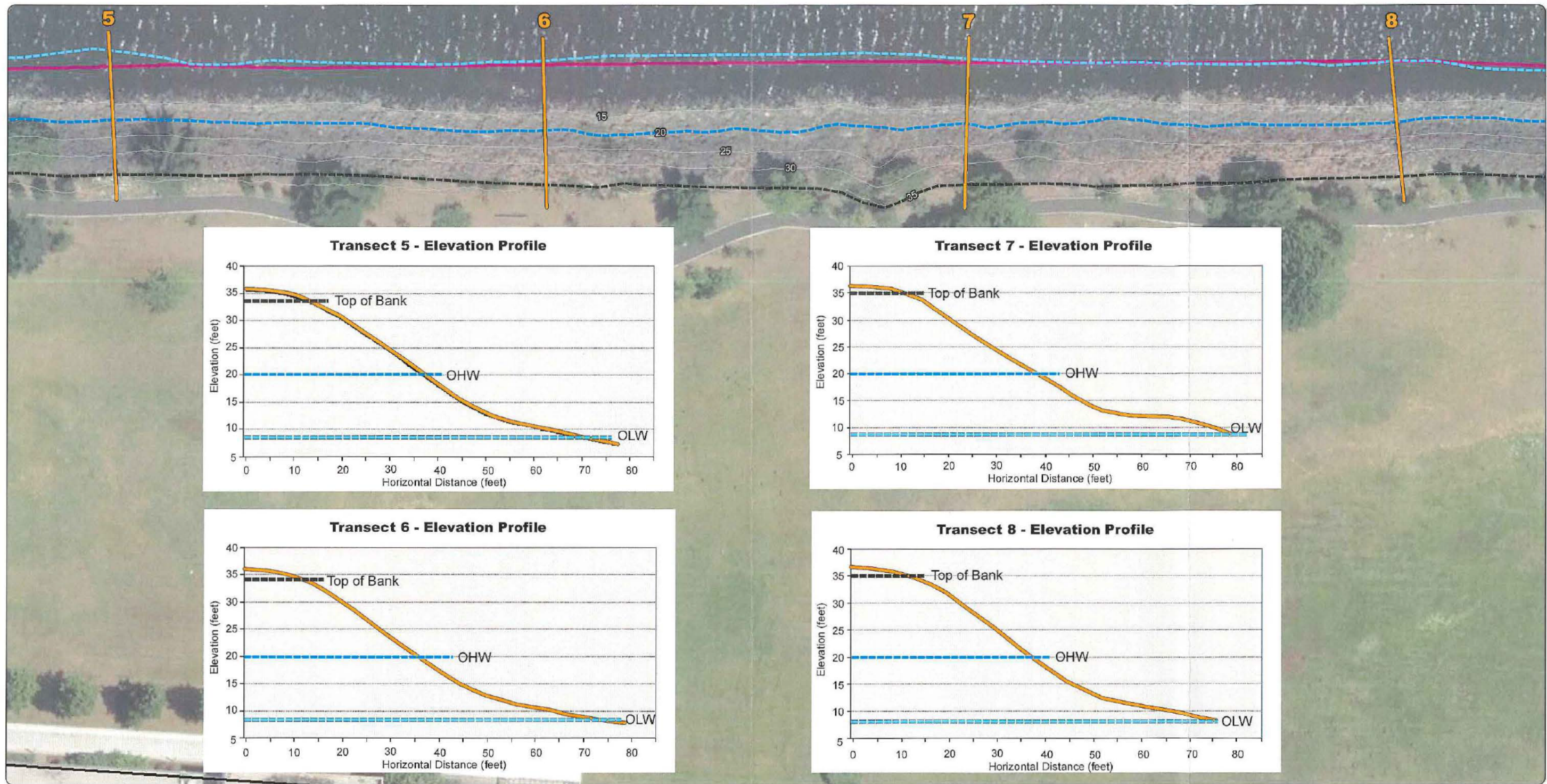
This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Note: NAVD88 = North American Vertical Datum of 1988.

- Legend**
- Riverbank Transect (with Transect ID)
 - Top of Bank
 - Ordinary High Water
 - Ordinary Low Water
 - Elevation (NAVD88, feet)
 - Photo
 - Site Building / Structure
 - Site Boundary

Figure 2
Riverbank Transects 1 - 4
Siltronic Corporation
Portland, Oregon





Source: Aerial photograph (2012) obtained from City of Portland; National Flood Hazard dataset obtained from FEMA; elevations obtained from 2005 Columbia River dataset, Puget Sound LiDAR Consortium; Ordinary High Water and Ordinary Low Water data obtained from Oregon Department of State Lands.

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for, legal engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

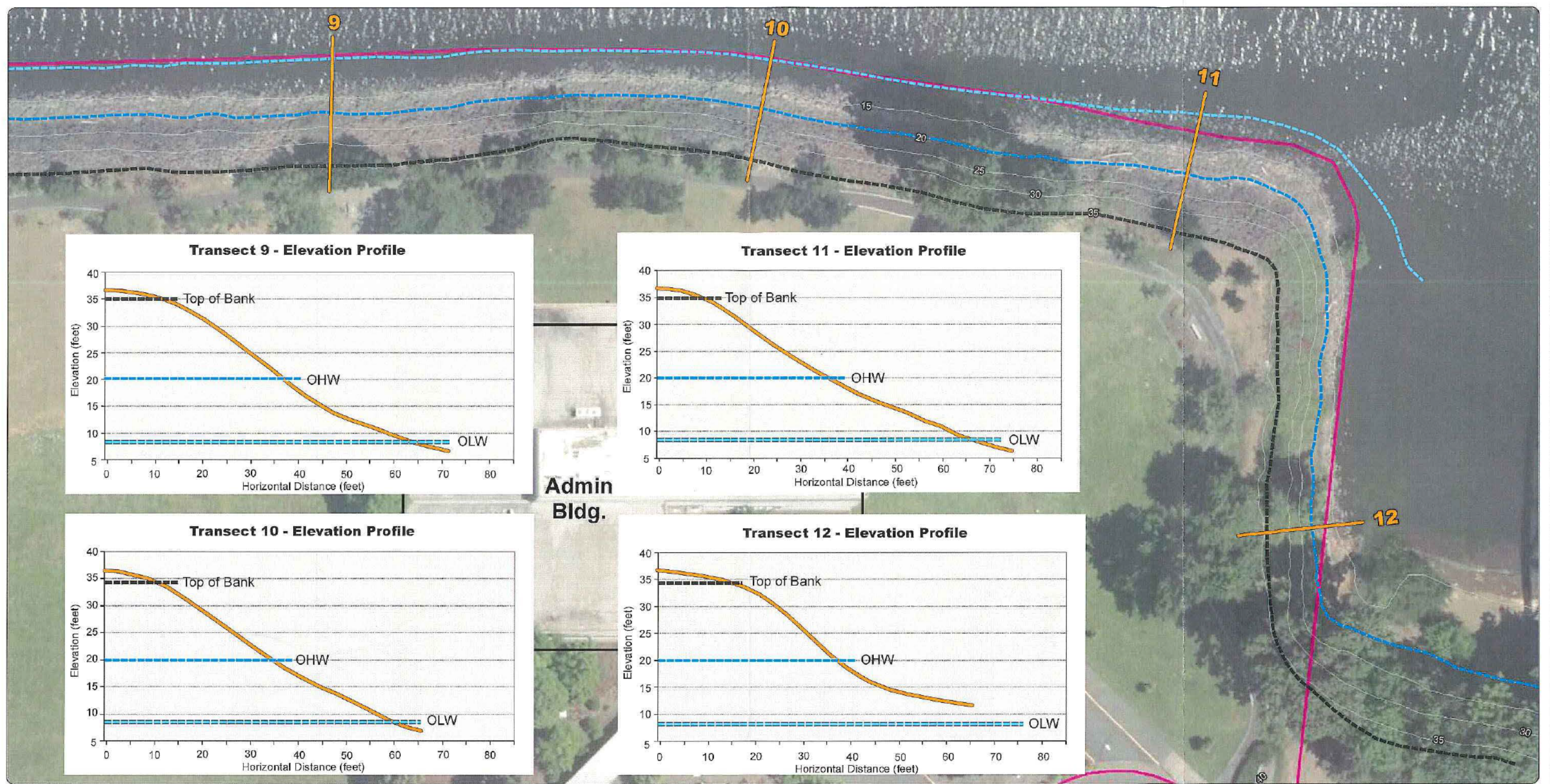
Note: NAVD88 = North American Vertical Datum of 1988.

- Legend**
- Riverbank Transect (with Transect ID)
 - - - Top of Bank
 - - - Ordinary High Water
 - - - Ordinary Low Water
 - Elevation (NAVD88, feet)
 - Photo
 - Site Building / Structure
 - Site Boundary

Figure 3
Riverbank Transects 5 - 8
Siltronic Corporation
Portland, Oregon

0 20 40
Feet





Source: Aerial photograph (2012) obtained from City of Portland; National Flood Hazard dataset obtained from FEMA; elevations obtained from 2005 Columbia River dataset, Puget Sound LIDAR Consortium; Ordinary High Water and Ordinary Low Water data obtained from Oregon Department of State Lands.

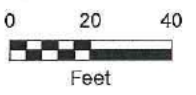
MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfooster.com

This product is for informational purposes and may not have been prepared for, or be suitable for, legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Note: NAVD88 = North American Vertical Datum of 1988.

- Legend**
- Riverbank Transect (with Transect ID)
 - Top of Bank
 - Ordinary High Water
 - Ordinary Low Water
 - Elevation (NAVD88, feet)
 - Site Building / Structure
 - Site Boundary

Figure 4
Riverbank Transects 9 - 12
Siltronic Corporation
Portland, Oregon



TABLES



Table 1
BEHI Transect Summary
Siltronic
Portland, Oregon

	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6	Transect 7	Transect 8	Transect 9	Transect 10	Transect 11	Transect 12
Study bank height to bankfull height ratio	1.25	1.33	1.33	1.25	1.25	1.33	1.33	1.33	1.33	1.33	1.33	1.33
BEHI	1	5	5	4	4	5	5	5	5	5	5	5
Root depth to study bank height ratio	0.33	0.31	0.31	0.33	0.33	0.31	0.63	0.31	0.63	0.31	0.31	0.63
BEHI	6	6	6	6	6	6	3	6	3	6	6	3
Weighted root density	16.67	7.81	15.63	8.33	16.67	7.81	31.25	15.63	31.25	7.81	15.63	43.75
BEHI	7.5	9	9	9	8	9	6	7.5	6	9	8	5
Bank angle	26	27	26	26	26	26	26	27	28	26	24	30
BEHI	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Surface protection	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
BEHI	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total BEHI Score	17.5	23	23	22	21	23	17	21.5	17	23	22	16
Bank material adjustment (Cobbles -10)	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
Total BEHI with adjustment	7.5	13	13	12	11	13	7	11.5	7	13	12	6
BEHI adjective rating	Very Low	Low	Low	Low	Low	Low	Very Low	Low	Very Low	Low	Low	Very Low
NOTE: BEHI = bank erosion hazard index.												

Table 2
Channel Stability Ratings
Sillrionc
Portland, Oregon

Stream: Willamette River			Location: Portland, Oregon				Valley Type:				Observers: Justin Pounds				Date:										
Loca-tion	Key	Category	Excellent		Good		Fair		Poor		Rating	Rating	Rating	Rating	Rating	Rating									
			Description	Rating	Description	Rating	Description	Rating	Description	Rating															
Upper banks	1	Landform slope	Bank slope gradient <30%.	2	Bank slope gradient 30–40%.	4	Bank slope gradient 40–60%.	6	Bank slope gradient > 60%.	8															
	2	Mass erosion	No evidence of past or future mass erosion.	3	Infrequent. Mostly healed over. Low future potential.	6	Frequent or large, causing sediment nearly yearlong.	9	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12															
	3	Debris jam potential	Essentially absent from immediate channel area.	2	Present, but mostly small twigs and limbs.	4	Moderate to heavy amounts, mostly larger sizes.	6	Moderate to heavy amounts, predominantly larger sizes.	8															
	4	Vegetative bank protection	> 90% plant density. Vigor and variety suggest a deep, dense, soil-binding root mass.	3	70–90% density. Fewer species or less vigor suggest less dense or deep root mass.	6	50–70% density. Lower vigor and fewer species from a shallow, discontinuous root mass.	9	<50% density plus fewer species and less vigor indicating poor, discontinuous, and shallow root mass.	12															
Lower banks	5	Channel capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0. Bank-Height Ratio (BHR) = 1.0.	1	Bankfull stage is contained within banks. Width/depth ratio departure from reference width/depth ratio = 1.0–1.2. Bank-Height Ratio (BHR) = 1.0–1.1.	2	Bankfull stage is not contained. Width/depth ratio departure from reference width/depth ratio = 1.2–1.4. Bank-Height Ratio (BHR) = 1.1–1.3.	3	Bankfull stage is not contained; over-bank flows are common with flows less than bankfull. Width/depth ratio departure from reference width/depth ratio > 1.4. Bank-Height Ratio (BHR) > 1.3.	4															
	6	Bank rock content	> 65% with large angular boulders. 12"+ common.	2	40–65%. Mostly boulders and small cobbles 6–12".	4	20–40%. Most in the 3–6" diameter class.	6	<20% rock fragments of gravel sizes, 1–3" or less.	8															
	7	Obstructions to flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed.	2	Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm.	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and pool filling.	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full, channel migration occurring.	8															
	8	Cutting	Little or none. Infrequent raw banks <6".	4	Some, intermittently at outcures and constrictions. Raw banks may be up to 12".	6	Significant. Cuts 12–24" high. Root mat overhangs and sloughing evident.	12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16															
	9	Deposition	Little or no enlargement of channel or point bars.	4	Some new bar increase, mostly from coarse gravel.	8	Moderate deposition of new gravel and coarse sand on old and some new bars.	12	Extensive deposit of predominantly fine particles. Accelerated bar development.	16															
Bottom	10	Rock angularity	Sharp edges and corners. Plane surfaces rough.	1	Rounded corners and edges. Surfaces smooth and flat.	2	Corners and edges well-rounded in two dimensions.	3	Well-rounded in all dimensions, surfaces smooth.	4															
	11	Brightness	Surfaces dull, dark, or stained. Generally not bright.	1	Mostly dull, but may have <35% bright surfaces.	2	Mixture dull and bright, i.e., 35–65% mixture range.	3	Predominantly bright, > 65%, exposed or scoured surfaces.	4															
	12	Consolidation of particles	Assorted sizes tightly packed or overlapping.	2	Moderately packed with some overlapping.	4	Mostly loose assortment with no apparent overlap.	6	No packing evident. Loose assortment, easily moved.	8															
	13	Bottom size distribution	No size change evident. Stable material 80–100%.	4	Distribution shift light. Stable material 50–80%.	8	Moderate change in sizes. Stable materials 20–50%.	12	Marked distribution change. Stable materials 0–20%.	16															
	14	Scouring and deposition	<5% of bottom affected by scour or deposition.	6	5–30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	12	30–50% affected. Deposits and scour at obstructions, constrictions, and bends. Some filling of pools.	18	More than 50% of the bottom in a state of flux or change nearly yearlong.	24															
	15	Aquatic vegetation	Abundant growth moss-like, dark green perennial. In swift water too.	1	Common. Algae forms in low velocity and pool areas. Moss here too.	2	Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick.	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present.	4															
Excellent Total =					Good Total =					Fair Total =					Poor Total =										
Stream type		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3	D4	D5	D6	Grand Total =	
Good (Stable)		38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98	Existing Stream Type =	
Fair (Mod. unstable)		44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125	*Potential Stream Type =	
Poor (Unstable)		48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+	133+	133+	128+	Modified channel stability rating =	
Stream type		DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2	G3	G4	G5	G6				
Good (Stable)		40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107				
Fair (Mod. unstable)		64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120				
Poor (Unstable)		87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+				
																								*Rating is adjusted to <i>potential</i> stream type, not existing stream type	

*Rating is adjusted to potential stream type, not existing stream type

Table 3
Channel Stability Summary
Siltronic
Portland, Oregon

Transect No.	Upper Banks				Lower Banks					Bottom						Total	Channel Stability Rating
	Landform slope	Mass erosion	Debris jam potential	Vegetative bank protection	Channel capacity	Bank rock content	Obstructions to flow	Cutting	Deposition	Rock angularity	Brightness	Consolidation of particles	Bottom size distribution	Scouring and deposition	Aquatic vegetation		
1	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
2	2	3	2	12	1	2	2	4	4	1	1	2	4	6	2	48	Good (Stable)
3	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
4	2	3	2	12	1	2	2	4	4	1	1	2	4	6	2	48	Good (Stable)
5	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
6	2	3	2	12	1	2	2	4	4	1	1	2	4	6	2	48	Good (Stable)
7	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
8	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
9	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
10	2	3	2	12	1	2	2	4	4	1	1	2	4	6	2	48	Good (Stable)
11	2	3	2	9	1	2	2	4	4	1	1	2	4	6	2	45	Good (Stable)
12	2	3	2	6	1	2	2	4	4	1	1	2	4	6	2	42	Good (Stable)
NOTE: BEHI = Bank Erosion Hazard Index.																	

ATTACHMENT 1

PHOTOGRAPHS





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

1

Description

Looking southeast on top
of bank near Transect #9.

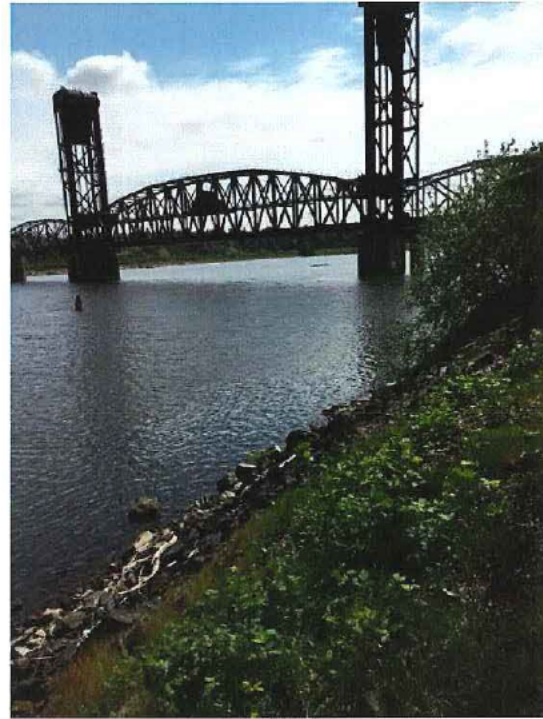
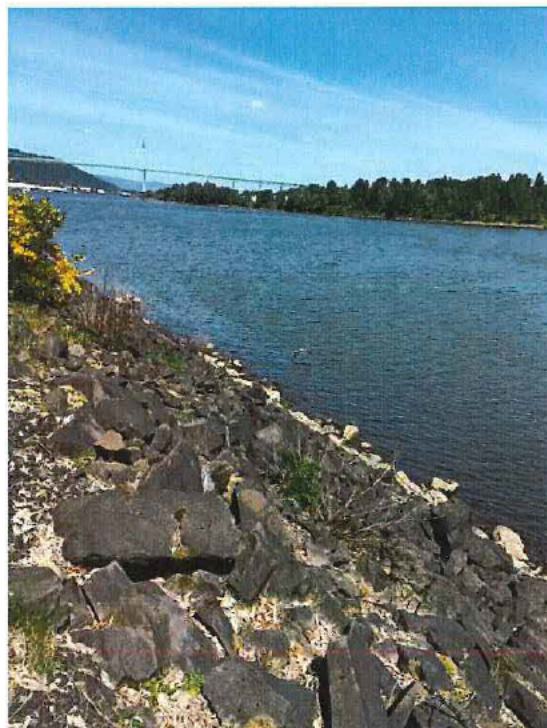


Photo No.

2

Description

Looking northeast on top
of bank near Transect #4.





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

3

Description

Looking northwest from
water of Transect #10.



Photo No.

4

Description

Trees on top of bank, looking west
at Transect #10 from water.





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

5

Description

Panoramic view of bank.





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

6

Description

Looking west at Transect #3 from water.



Photo No.

7

Description

Looking west at Transect #5 from water.





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

8

Description

Looking west at Transect #9 from water.



Photo No.

9

Description

Looking west at Transect #11 from water.





PHOTOGRAPHS

Project Name: Siltronic Bank Survey
Project Number: 8128.02.03
Location: 7200 Northwest Front Avenue
Portland, Oregon

Photo No.

10

Description

Looking west at Transect #12 from water.



ATTACHMENT 2

BEHI FIELD DATA SHEETS



BEHI Rating Scale
(Rosgen, 2014)

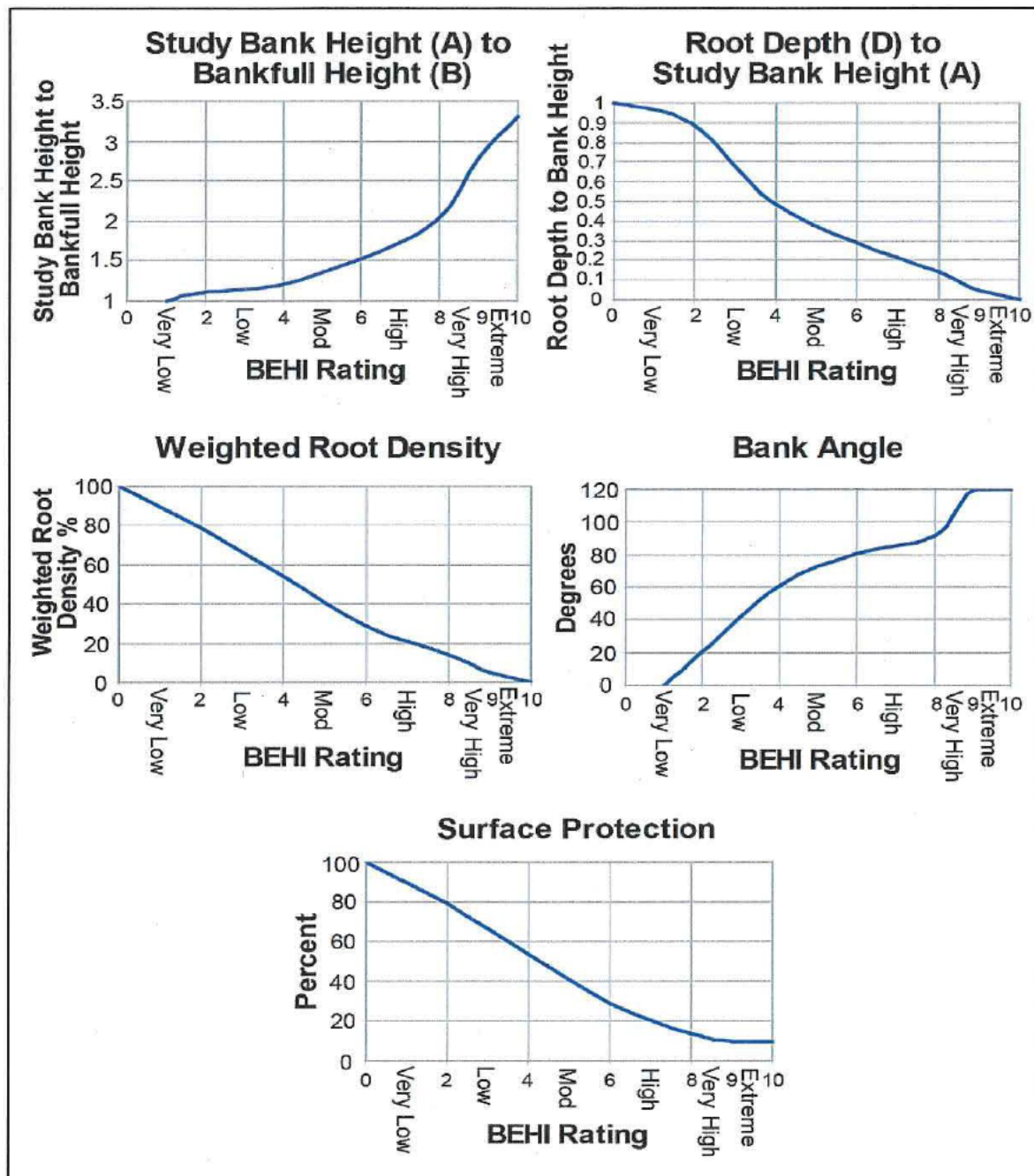
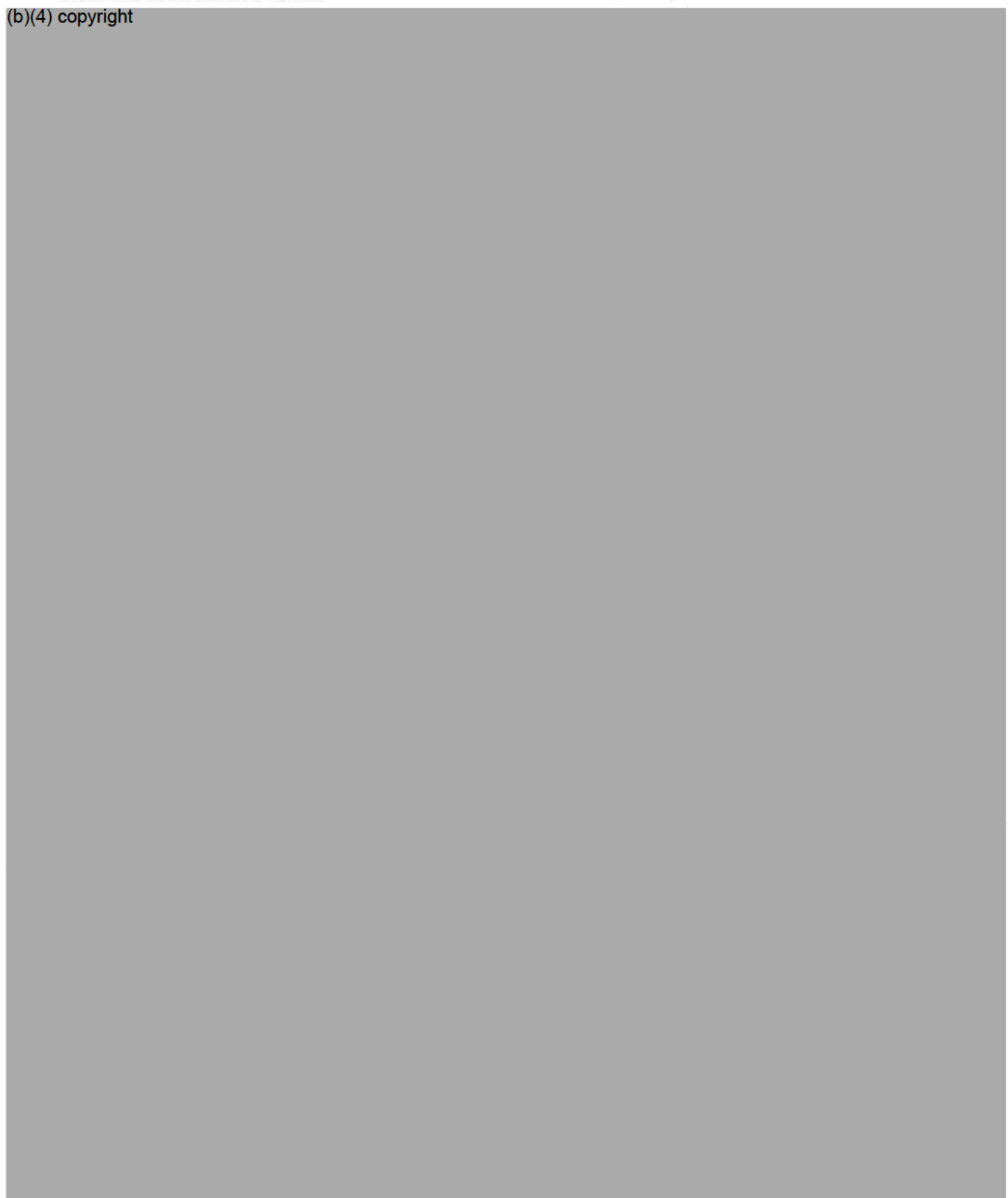


Figure 3-7. Streambank erodibility criteria showing conversion of measured ratios and bank variables to a BEHI rating (Rosgen, 1996, 2001b, 2006b). Use **Worksheet 3-11** to determine BEHI score.

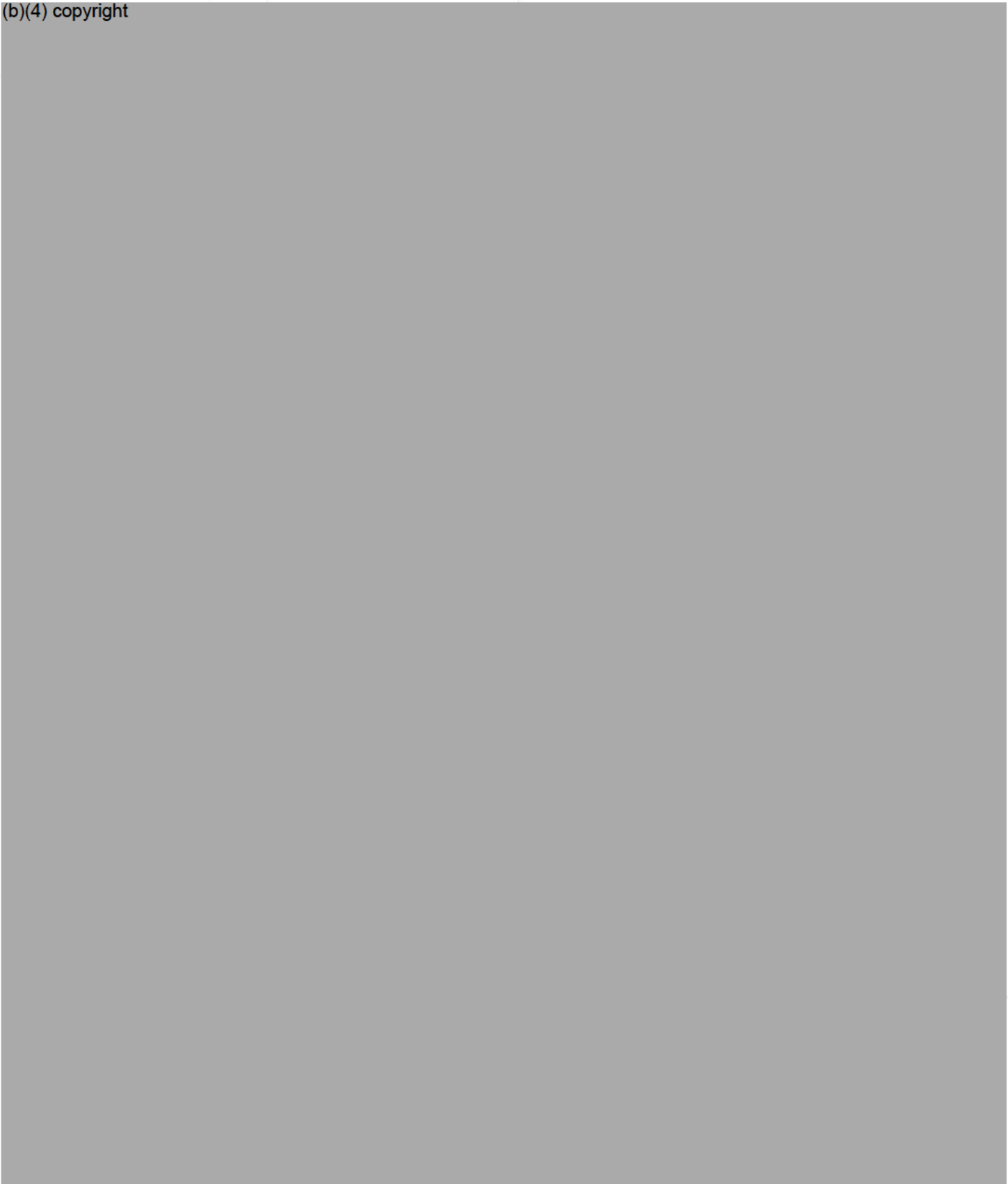
Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright




Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



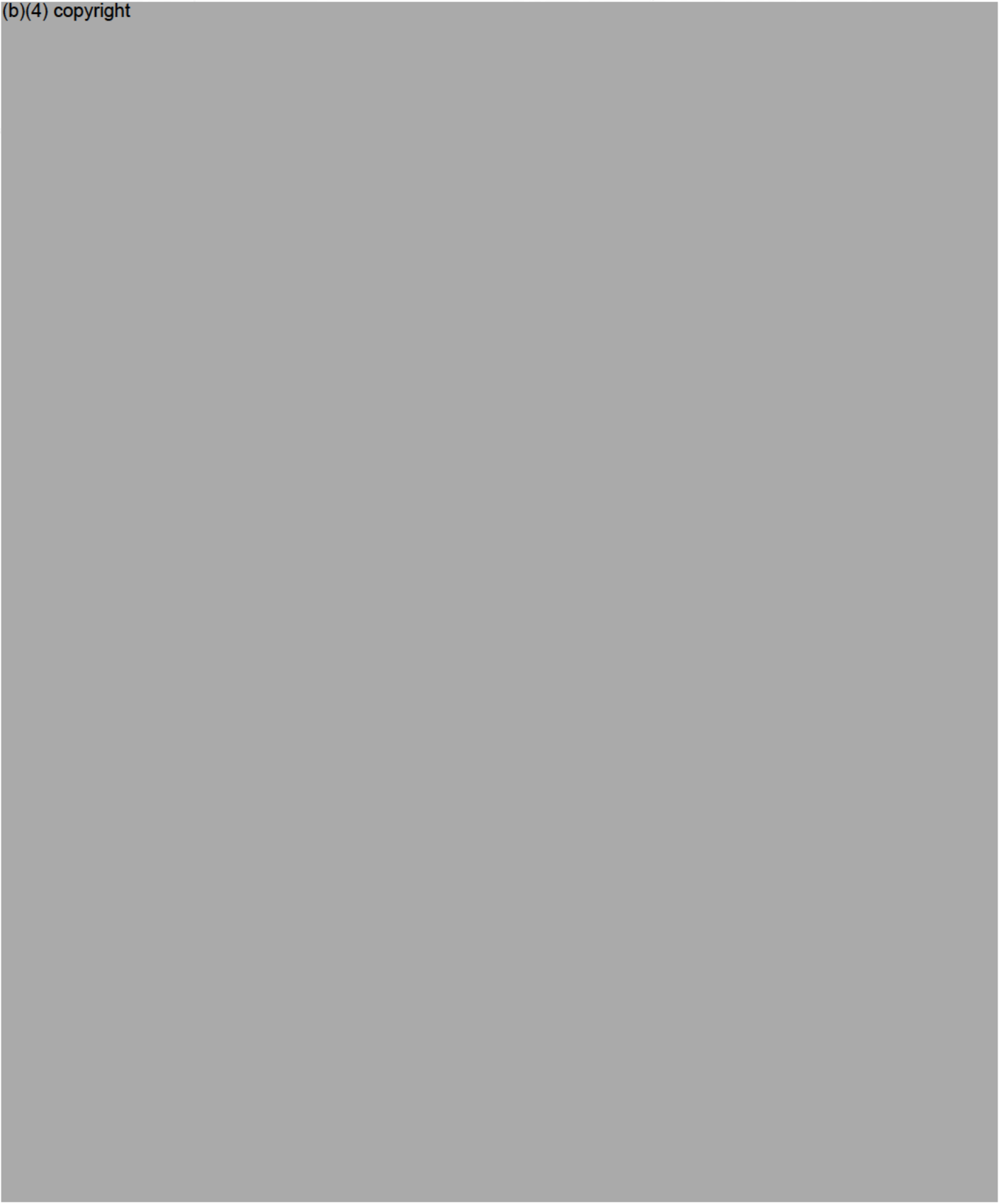
Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



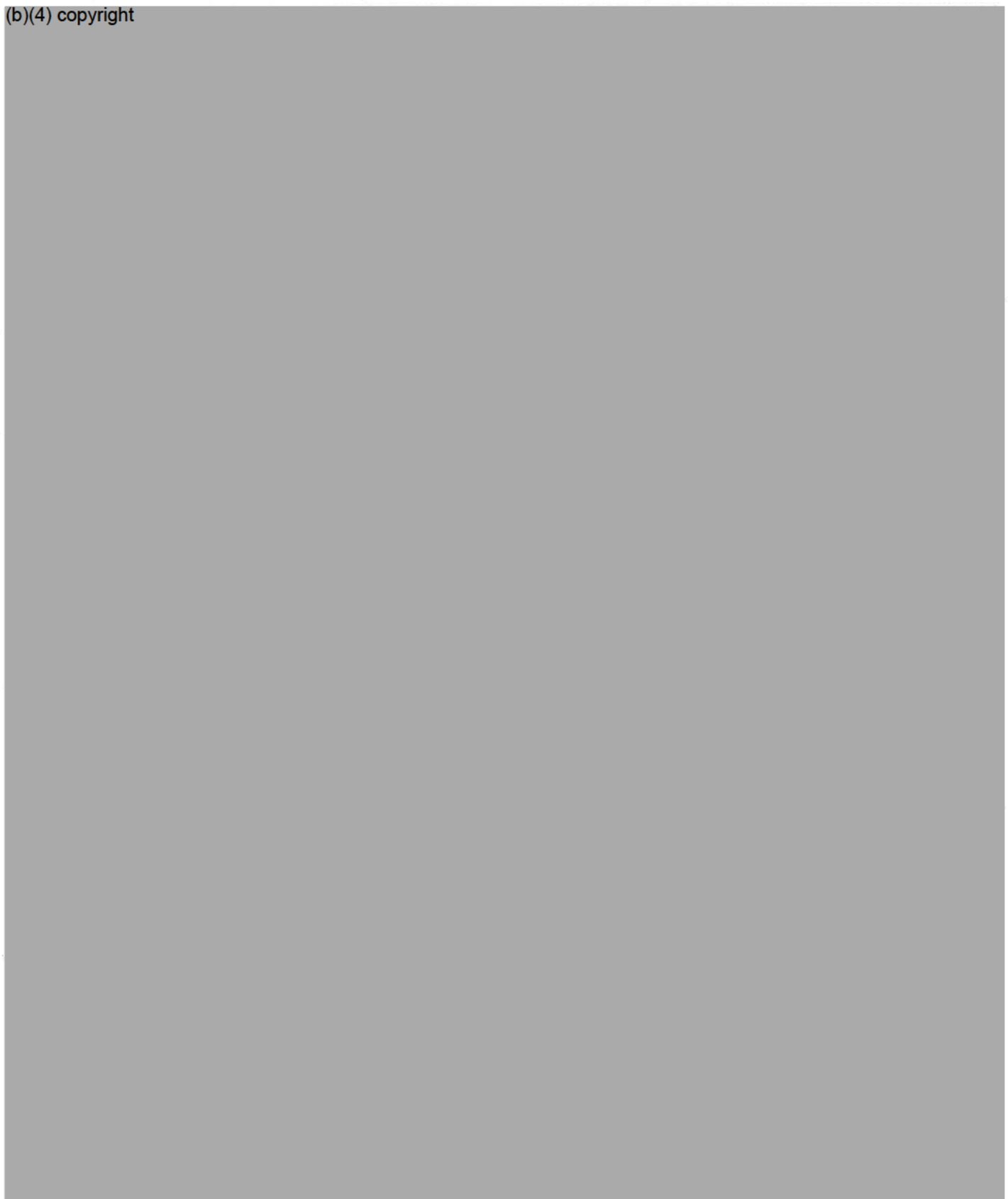
Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



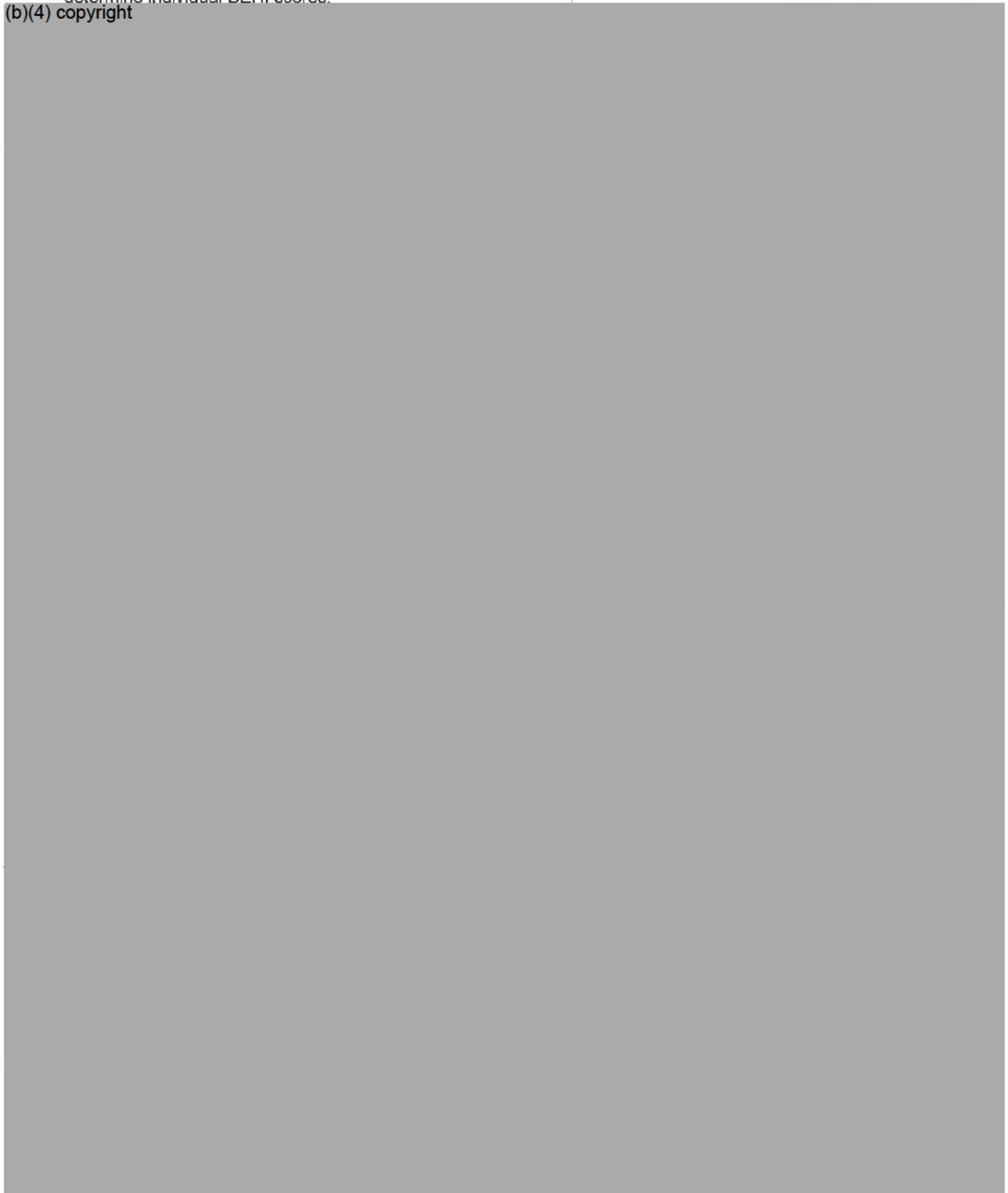
Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright




Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright




Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



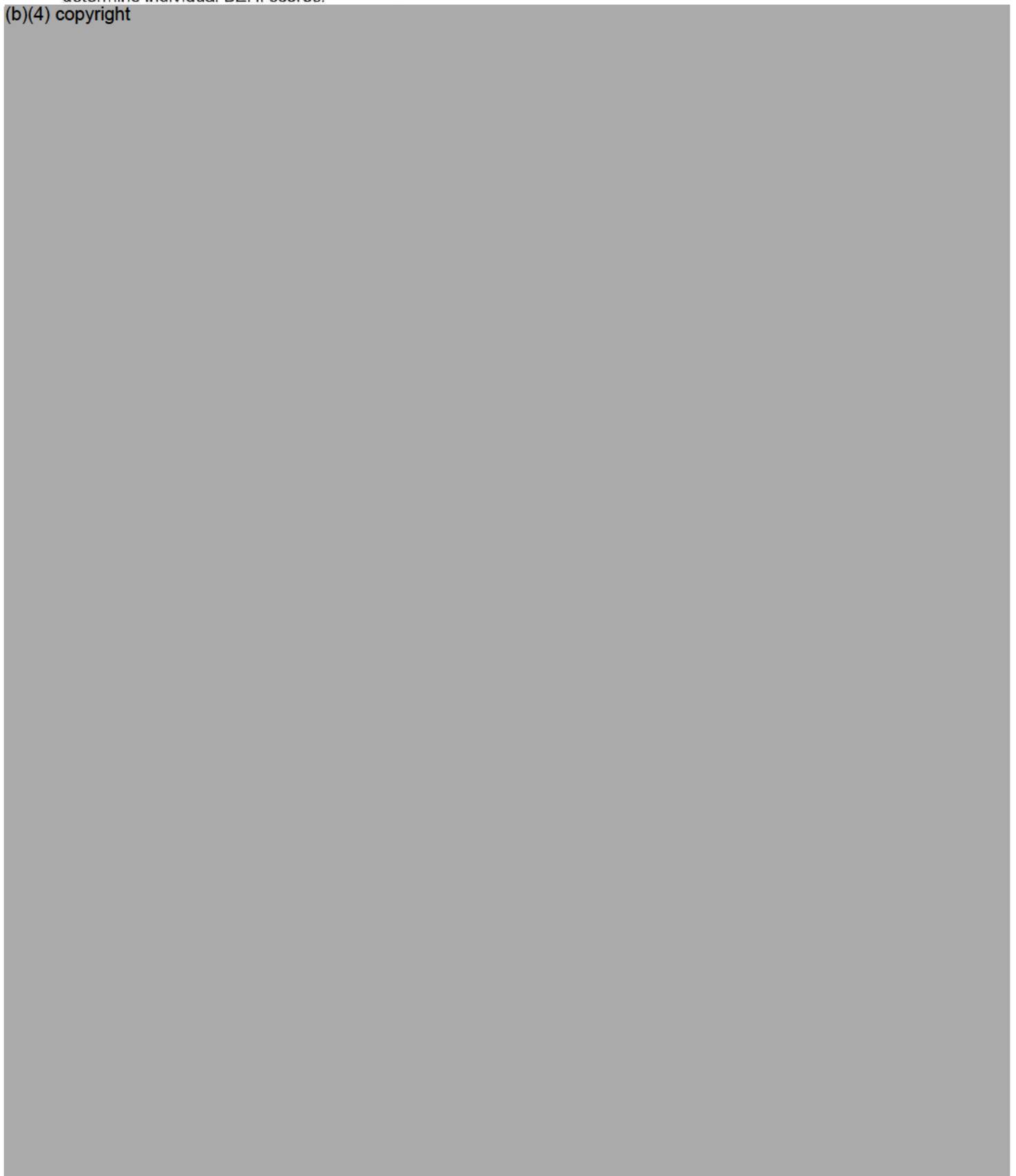
Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright



Worksheet 3-11. Form to calculate an overall Bank Erosion Hazard Index (BEHI) rating. Use **Figure 3-7** to determine individual BEHI scores.

(b)(4) copyright

